THE JOURNAL OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

· APRIL · 1916 ·

SPRING MEETING, NEW ORLEANS, APRIL 11-14

THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

CONTENTS

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EVERY MEMBER OF THE SOCIETY

has received by mail a folder giving full particulars of the Spring Meeting arrangements, including transportation schedules, fares, hotel accommodations and rates, and a tentative program of the professional and social features of the meeting.

The papers to be presented and discussed are:

Wednesday morning, April 12

ORGANIZING FOR INDUSTRIAL PREPAREDNESS, Spencer Miller, Member of Council, Am. Soc. M. E., Member Naval Consulting Board.

Thursday morning, April 13

CAPACITY AND ECONOMY OF MULTIPLE EVAPORATORS, E. W. Kerr, Mem. Am. Soc. M. E.

THE EVOLUTION OF LOW LIFT PUMPING PLANTS IN THE GULF COAST COUNTRY, William B. Gregory, Mem. Am. Soc. M. E.

MECHANICAL EQUIPMENT USED IN THE PORT OF NEW ORLEANS, William von Phul, Mem. Am. Soc. M. E.

Friday morning, April 14

ESTABLISHING A STANDARD OF MEASUREMENT FOR NATURAL GAS IN LARGE QUANTITIES, Francis P. Fisher, Mem. Am. Soc. M. E.

DEVIATION OF NATURAL GAS FROM BOYLE'S LAW, Robert F. Earhart and Samuel S. Wyer, Mem. Am. Soc. M. E.

SOME EXPERIMENTS ON WATER-FLOW THROUGH PIPE ORIFICES, Horace Judd, Mem. Am. Soc. M. E.

THE MEASUREMENT OF VISCOSITY AND A NEW FORM OF VISCOSIMETER, H. C. Hayes and G. W. Lewis.

DYNAMIC BALANCE, N. W. Akimoff.

DISASTROUS EXPERIENCES WITH LARGE CENTER-CRANK SHAFTS, Louis Illmer, Mem. Am. Soc. M. E. (Contributed by the Gas Power Committee.)

ON THE TRANSMISSION OF HEAT IN BOILERS, E. R. Hedrick and E. A. Fessenden, Mem. Am. Soc. M. E.

As announced in the folder, a stop-over by the party going to New Orleans by rail will be made at Birmingham, Ala. The Birmingham Local Section has now arranged an elaborate program for the members and guests who make this stop-over. This will include a trip on a special train to the Republic Iron & Steel Co.'s Furnaces, the Ensley Furnaces, and the hearths and mills of the Tennessee Coal & Iron R. R. Co.; a Barbecue at Bayview; visits to the works of the American Steel & Wire Co. and to the Manufacturers' Exhibit Building in Birmingham; also a dinner at the Tutwiler Hotel.

See Page 313 Inside.

HEADQUARTERS AT NEW ORLEANS—HOTEL GRUNEWALD

COMING MEETINGS OF THE SOCIETY

April 5, *Boston, Mass.* Subject: Shoe Manufacturing and Shoe Machinery, by Joseph Gillespie. The lecture is to be illustrated by moving pictures.

April 5, *New Haven, Conn.* This will be a joint meeting with the Electrical, Civil, and Mining Engineering Societies. The meeting will take place at the Mason Laboratories, Sheffield Scientific School. Dinner at Yale Dining Club, 6 p. m. Evening session, 7 p. m. Illustrated address by Samuel Insull, president of the Commonwealth Edison Co., Chicago, Ill., on The Progress of Economic Power Generation and Distribution.

April 5, *St. Louis, Mo.* Subject: Engineering Geology, by Professor McCort of Washington University.

April 10, *Philadelphia, Pa.* A joint meeting with the American Institute of Electrical Engineers. Subject: The Possibilities of Some Prime Movers Now Under Development, including Diesel engines, unaflow engines, locomobiles, and steam-gas units.

April 12, *Buffalo, N. Y.* Subject: Bringing a Shop up to Date, by Fred Kent, general manager of the Lodge & Shipley Company, Cincinnati, Ohio.

April 12, *St. Louis, Mo.* Subject: Railroad Signals, by B. H. Mann of the Missouri Pacific R. R.

April 14, *Minneapolis, Minn.* The Minnesota Section has accepted an invitation to attend a joint meeting with the American Institute of Electrical Engineers and the American Society of Civil Engineers.

April 19, *St. Louis, Mo.* Subject: French Warfare and Field Fortifications, by Major Willing.

April 20, *New York, N. Y.* Joint meeting with the Society of Automobile Engineers. Subject: Automobile Power Plants.

April 25, *Philadelphia, Pa.* The section will be addressed by Dr. D. S. Jacobus.

April 26, *Buffalo, N. Y.* Subject: Industrial Mobilization.

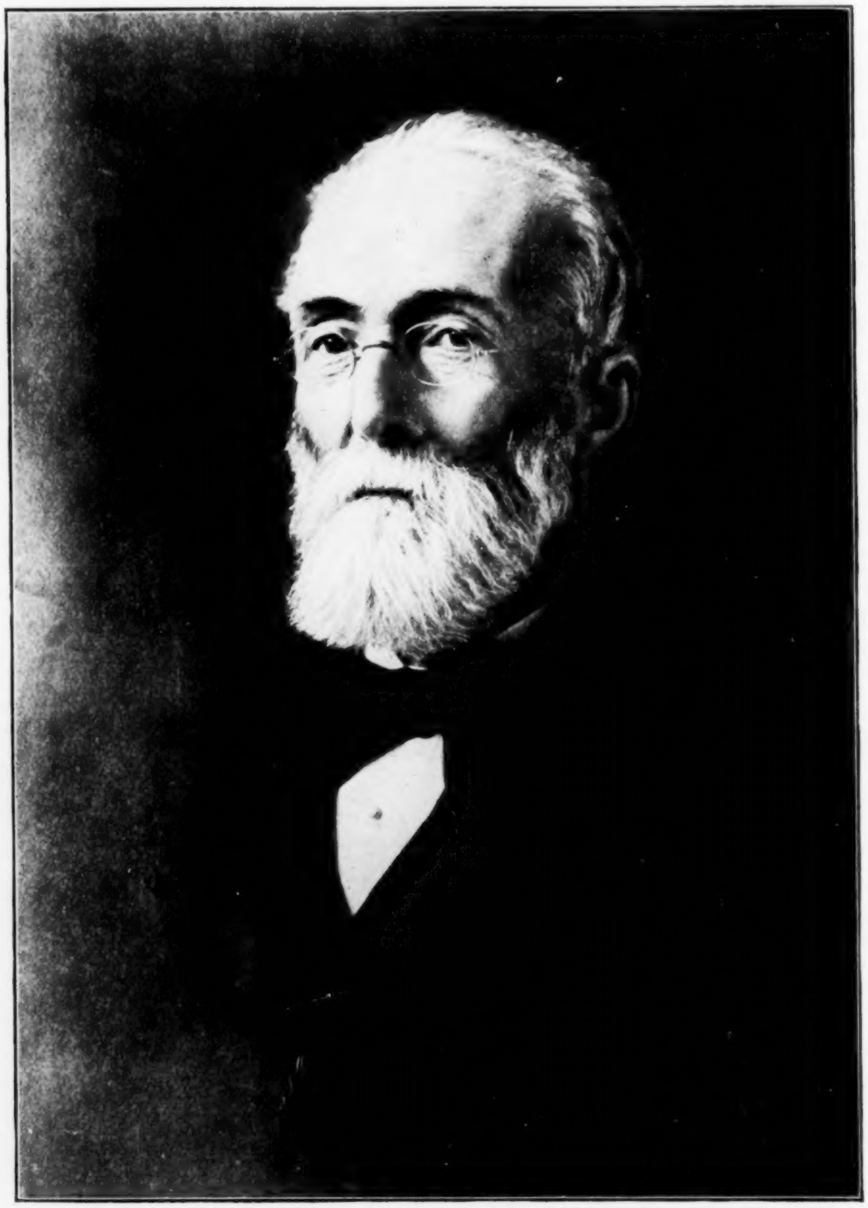
April 26, *Providence, R. I.* Engineers' Dinner.

May 15, *Chicago, Ill.* Subject: The Use of Powdered Coal as Fuel, by Joseph Harrington, Advisory Combustion Engineer, Chicago, Ill.

May 23, *Philadelphia, Pa.* Subject: Naval Engineering, or a kindred subject, by a representative of the Department of Steam Engineering of the Navy.

THE SPRING MEETING

April 11–14, *New Orleans, La.* Spring Meeting of the American Society of Mechanical Engineers. Headquarters, Hotel Grunewald. Full details concerning the attractions and the tentative program are given in the announcement of the meeting appearing elsewhere in this issue, followed by abstracts of the papers to be presented.



ERASMUS DARWIN LEAVITT ONE OF THE ORIGINAL MEMBERS OF THE SOCIETY. VICE-PRESIDENT, 1881-82. PRESIDENT, 1883. HONORARY MEMBER, 1915. DIED MARCH 11, 1916

ANNUAL MEETING PAPERS

THE final session of the 36th Annual Meeting of the Society held in New York, December 7-10, 1915, was devoted to papers on Industrial Safety. There were four papers contributed by the Sub-Committee on the Protection of Industrial Workers, as follows: Standardization of Safety Principles, by Carl M. Hansen; Modern Movement for Safety from Standpoint of Manufacturer, by Melville W. Mix; The Attitude of the Employer Towards Accident Prevention and Workmen's Compensation, by W. H. Cameron; Industrial Safety and Principles of Management, by W. P. Barba. The first three of these papers are published in abstract form in this issue; Mr. Barba's paper appeared in the December 1915 issue of The Journal.

STANDARDIZATION OF SAFETY PRINCIPLES

BY CARL M. HANSEN, NEW YORK

Member of the Society

WITH the dawn of the twentieth century, it was seen that we had achieved an efficiency in our industries surpassing that in all other countries. The machine tools of the United States, for instance, were recognized as superior to any manufactured elsewhere. Through the clogging of our courts with litigation involving injuries to operators of these machines, however, we began to ask ourselves if in our zeal for productive efficiency of machines, we had not overlooked one vital factor. Were these machines reasonably safe for those workers who had to give them constant or intermittent attention?

With an annual toll of upward of fifty thousand workers killed and approximately two million others more or less serious, but non-fatal accidents, we realized that we were rapidly on the road to creating a nation of cripples, and that in order to measure true efficiency in our industries it would be necessary to take into account the economic loss occasioned by all these work accidents. In taking stock to that end we found that an amount of between five and six hundred million dollars had to be added to our cost of production in order to collate an exhibit of our true efficiency.

Some of our larger corporations, particularly the United States Steel Corporation, The International Harvester Company and several others, at the same time, and even earlier began to study the subject and someone—who it was has never yet been finally decided—coined the happy expression "Safety First." It was recognized that compensation for injuries was a just and equitable plan, generally in the interest of society at large, but that if we could prevent the injuries from happening we should eliminate not alone a tremendous amount of human suffering and hardship, but we should make one of our greatest forward steps in economic efficiency. The whole movement was characterized by duplication of action and resulting inefficiency, until at last in the fall of 1912 the National Safety Council was formed in the City of Milwaukee for the purpose of bringing to some extent harmony out of the existing conflict of opinions. This organization, now embracing a membership of many of the most progressive corporations and individuals in every state of the Union, has done splendid work. It has been a powerful factor in arousing public opinion to the subject and in bringing it to the stage where the engineering profession must take due cognizance of it and do their share in bringing about universal safety.

It is through standardization that engineers must play their most important role and in the standardization of safety principles there are the five requirements, to put the matter tersely, that these principles must be high, comprehensive, practical, simple and positive.

By high standards is meant those which afford all possible safety to life, limb and property from accident and fire hazards; that a building or a piece of equipment is safe enough only when it is as safe as it can possibly be made or only when it is as safe as any other building or piece of equipment designed to perform the same function.

By comprehensive standards, is meant those which embody not alone the equipment in a building, but the building itself as well, and not only a plant in New York, but rather any plant regardless of location.

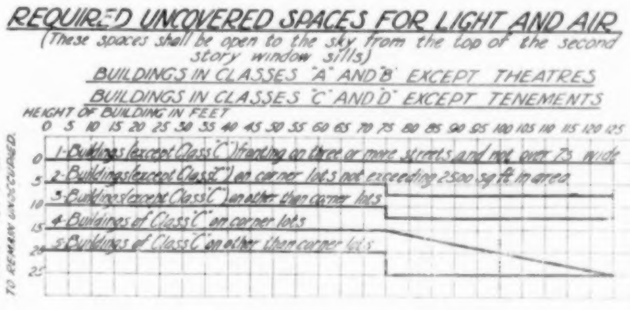


FIG. 1 SAFE AREAS OF BUILDINGS ON CITY LOTS

By practical, is meant those which do not destroy or distort either the convenience or efficiency of the equipment to which they are applied.

By simple, is meant that they be so prepared that they will be readily understood and applied by the ordinary mechanic, that the safest way will always be the easiest way.

By positive standards is understood to be meant that they will eliminate the hazard for which they were designed; that is, that they will do something, or cause something to be done, or absolutely prevent something from being done, rather than simply serving as a suggestion—that, in other words, they can be depended upon for unfailing action with as little consideration as possible for the universally uncertain human factors, such as knowledge, memory and involuntary acts, etc.

In the following an attempt will be made to illustrate these principles in actual application. Commencing with a typical factory building, the supposition is that the site has been selected and that the problem is to design and equip the building for maximum safety without interfering with efficiency or convenience.

Presented at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 1915. Pamphlet copies without discussion may be obtained: price 10 cents to members, 20 cents to non-members.

An isolated factory presents few difficulties, but the city factory offers problems in planning, due to the proximity of other buildings, which must be regulated by standards. It has been determined that a certain percentage of the lot must remain uncovered in order to provide sufficient air and light. What that area of unoccupied space should be, given the size of the lot, is indicated in Fig. 1. This illustration shows the

The windows exposed to fire hazard from other buildings are glazed with wire glass set in metal sash. All lintels are far enough below the ceiling so that the heated gases will be contained to operate automatic extinguishers and so that flames breaking out through the windows are diverted from the other wall openings.

Even allowing for this and for the minimum width of piers,

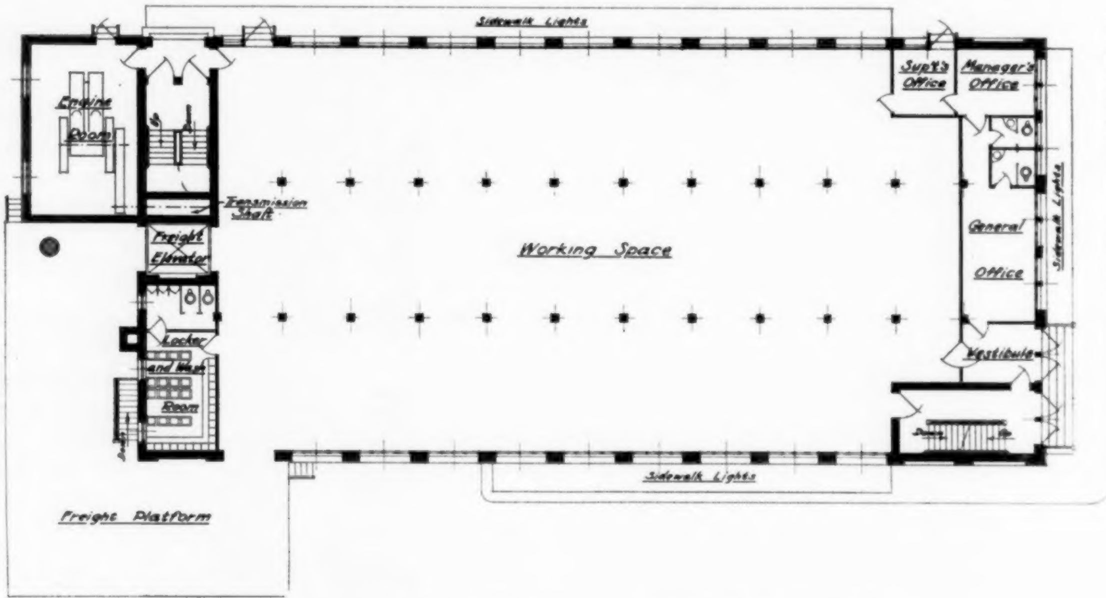


FIG. 2 FACTORY BUILDING MILL CONSTRUCTION. FIRST FLOOR PLAN

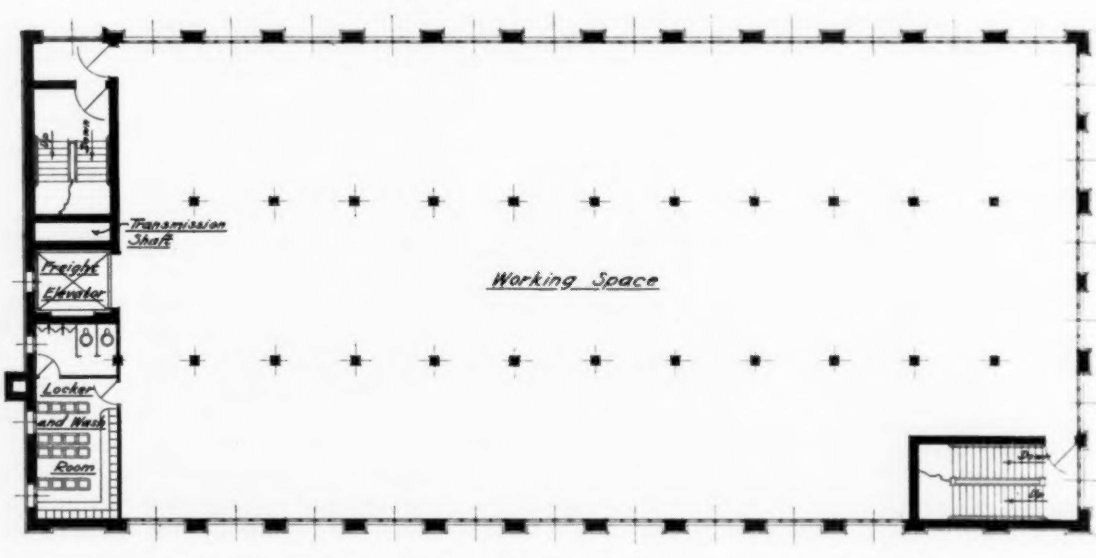


FIG. 3 FACTORY BUILDING MILL CONSTRUCTION. TYPICAL FLOOR PLAN

percentage of area which can safely be occupied with any class of building on any type of a city lot.

Having determined the outline of the plan, the next step is to determine means of rapid and safe egress which at the same time will not interfere with the efficiency of the manufacturing processes and are based on total occupancy of building. Figs. 2, 3 and 4 show suggested arrangements of such a plan by means of stairs enclosed in fire resisting walls and smoke proof towers.

As will be noted, the power plant and the vertical transmission shafts are separated from the rest of the building to prevent the spread of fire, and elevator shafts are inclosed in fire resisting walls and equipped with automatic fire doors.

ample lighting facilities are obtained. Space is provided for toilets and wash rooms having outside light and ventilation and with a sufficient number of wash basins and other toilet facilities to accommodate the employees.

The construction should be fire resisting to a high degree, as illustrated in Fig. 5, but in case this should prove too expensive, owing to location or other circumstances, a good type of slow-burning construction may safely be adopted. Whether it be fireproof or slow-burning mill construction, fire fighting equipment should be provided, such as automatic sprinklers, wall and yard hose, portable extinguishers, etc.

It is admitted that no specific standard can be laid down which will embody specifications covering any or all of the

foregoing. All that the author is endeavoring to show in these illustrations is the principle which must be applied to the particular problem confronting the architect or engineer in designing a building and he desires to emphasize the fundamental fact that these principles are essential.

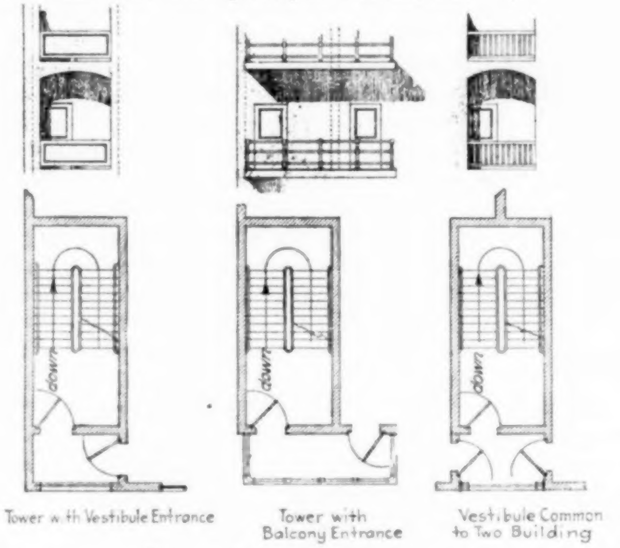


Fig. 4 Smoke Proof Towers

ing products of the controlling political parties, is it not too much to assume that scientific results will be obtained?

As practical men, however, it would be impossible to condemn all buildings now in existence which do not embody the ideal safety principle. Our plan must therefore include existing buildings as well.

Taking the building, for example, where adequate means of egress has not been provided, it may be necessary to overcome this deficiency by means of outside exit stairways of a type as shown in Fig. 6, but under no circumstances should the so-called "fire escapes" as commonly known be countenanced, that is, exits with such objectionable features as gridiron balconies connected by open stairs, or ladders or exits so located that they adjoin windows.

The horizontal exit obtained by means of bridges connecting adjoining buildings, or in the case of large floor areas the breaking up of the area with fire resisting partitions and automatic fire doors, are very effective means for promoting safety from the fire hazard in many existing buildings and it is quite incomprehensible why those plans are not more extensively used. This method places safety zones immediately next to the danger zones.

It is naturally impossible in a paper of this nature to go largely into details. There are many more questions which properly should be considered in connection with buildings

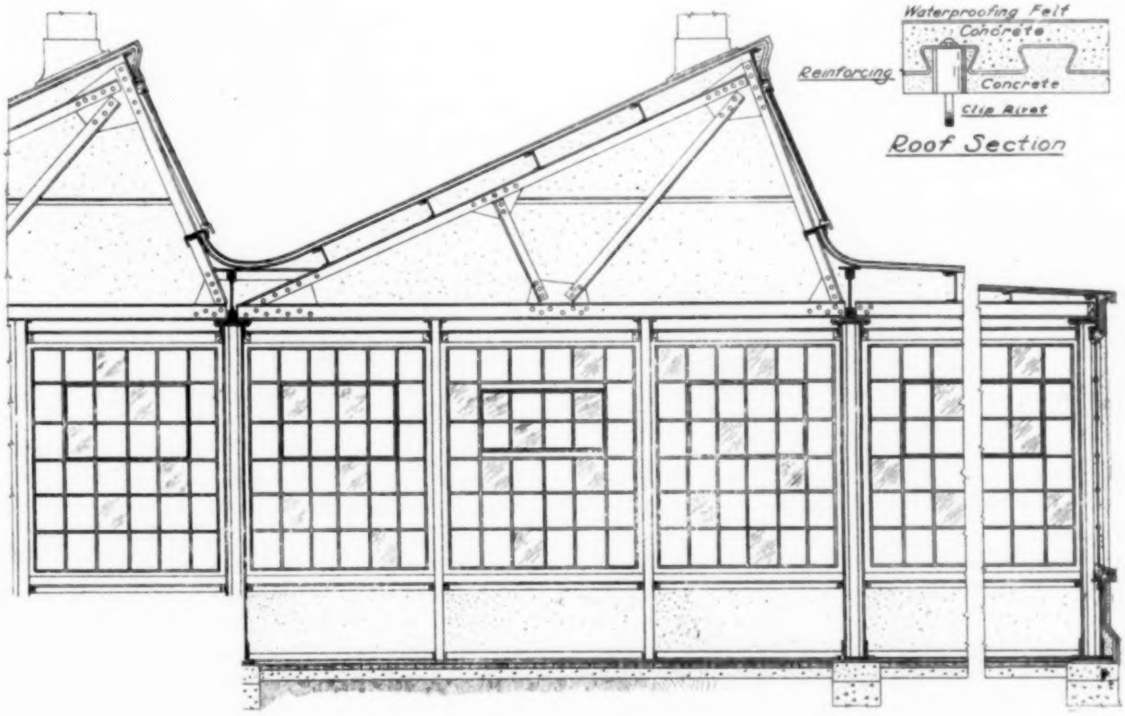


Fig. 5 Saw Tooth Factory Construction

It may be maintained that all these factors are having careful attention at this moment and are being embodied in modern structures. It is admitted that such is the case in individual instances, but as a general rule—No! Facts are against such a contention. Very few factory and even few office buildings which have been designed and built in this country in the last few years are truly safe for the occupants. It is not asserted that they fail to comply with existing codes, law and regulations, but as long as each individual city has its own building code, often based upon the particular market of its locality and dominated by the build-

but it is hoped the foregoing will illustrate the points involved.

We next come to the selection and installation of machinery and equipment generally. Where machine tools are to be used, only those should be specified which have all possible safeguards embodied in original design; that is, as an integral part of the machine itself. A safeguard on a machine should not be an extra attachment or an after-thought; it should be as much an original part of that machine as are the gears or the pulleys. A manufacturer of machine tools should consider it an insult to have a purchaser of his prod-

uct add parts or equipment to it after it has been installed.

Gears are necessary on certain classes of machines for the transmission of power, but no engineer will admit that these gears have to run openly in order to perform their function. Knowing that as long as they run openly they present a hazard, and knowing further that it is an unnecessary hazard and that it will not reduce the efficiency of the machine to eliminate it, it must appeal as a logical proposition that such elimination should be effected in original design rather than after the machine has been installed. This applies equally to all other points creating an accident hazard.

In order to meet the principle of safety a guard for a machine should be so constructed as to prevent the removal or misuse of its essential parts. Wherever possible, it should be so designed in relation to the machine to which it is applied that the machine cannot be operated unless the safeguard is in position. This may seem to present insuperable difficulties in the design of certain types of machines. It has been the author's experience, however, that where concentrated study has been given to that particular principle in machine design, it has been met in every instance. Fig. 7 indicates the principle applied in the door-lock on a laundry extractor. This principle is again illustrated in Fig. 8.

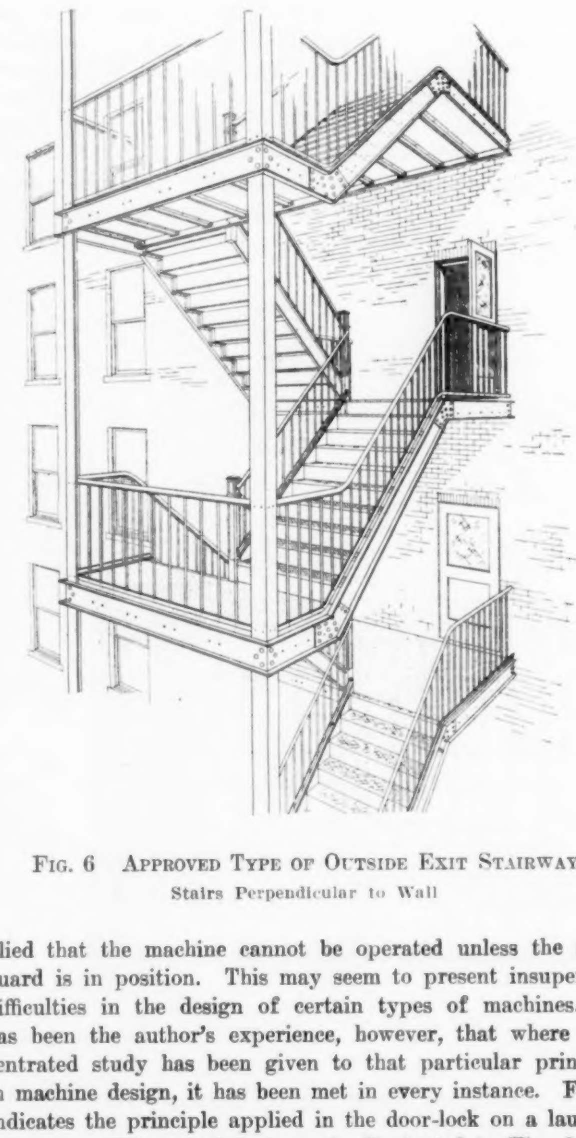


Fig. 6 Approved Type of Outside Exit Stairway
Stairs Perpendicular to Wall

A further study of the question of safeguarding has brought out the fact that the application of a safety principle often increases the efficiency, as, for instance, in the case of stamping presses equipped with slide and gravity feeds, as shown in Fig. 9. It is a fact well established in stamping press operations that that method of feed naturally increases the output on the machines and often produces that result. It must be noted, however, that the automatic feed as such does not in itself form a complete guarding of that press. Some further protection must be provided, making it impossible for the attendant to put his or her hands in the actual danger zone during the downward stroke of the ram.

If from a construction standpoint the building is properly provided with all safety features, and the machinery and equipment with its belts, pulleys, gears, set-screws, couplings, etc., embody all safety principles, there are still other hazards which must be carefully considered and the principle for elimination of these hazards established. The slipping hazard is one of the most important. A careful study of many accidents as reported has brought out the fact that slippery surfaces constitute one of our largest contributory causes to such accidents. That the slipping hazard is easily and can be practicably eliminated by the introduction of anti-slip surfaces on all stairs and on all floor surfaces where employees or other occupants of buildings frequent is an established fact. It is particularly necessary that such anti-slip surfaces be used around machinery.

Having proven, so the author hopes, the necessity of safety as an essential principle in the design of buildings and their equipment; having further proven the practicability of such safety principles; and having reinforced this by showing the apparent need of standardization in the premises, the question is before us of where and how shall we obtain such standards? The answer lies in another question: Where did we get our industries? Who is responsible for the hazards in these industries? We—the engineers. We have created the machines used and it is up to us to eliminate any unnecessary hazard which these machines have introduced.

The unfortunate phase of the whole subject is that up to now safety has been dealt with as a legal subject. We have left it to our courts, to our lawyers, to decide whether or not a building or a machine was safe for its occupants or operators. Now, the author maintains that safety never was and never should have been made a legal question. It is not a question of law; it is in every instance a question of fact, and who is more competent to deal with questions of fact than engineers, especially when these facts pertain to their own business?

To give a typical illustration of legal and engineering standards: The hazard of moving elevators and open shaft doors has long been recognized through occurrence of hundreds of fatal and serious non-fatal accidents. Legislators in different municipalities and states have passed statutes to the effect that it shall be deemed unlawful for an elevator operator to start his car until the doors of the shaft are closed and latched. This is a typical standard produced by legislators. But does this prevent the occurrence of elevator accidents from open doors? It does not, because it is impossible to enforce the act in time to prevent the accident. The only thing that such a statute accomplishes is to establish responsibility for the accident after it has occurred.

Let us consider briefly how an engineer would solve the same problem. He would analyze the mechanism of the elevator, the door, and the motive power. He would find the contributing causes which produced the hazard and re-design his elevator so that it would become impossible for the operator to reproduce the dangerous conditions, and would compel him to perform a certain act before he could get motive power—the act in this case consisting in closing the door in order to move his operating lever.

When engineers have developed such a principle and shown it to be a practical one, our legislators may well assist them in giving legal force to it, but this should be done without

any unnecessary phraseology. To write a law book on a question of fact which can be expressed in a line is folly.

Before closing, it is desired to express a further word in respect to building design. Our architects may well say this is an architectural problem and one which should be left to them to deal with and solve. Let it be clearly understood there is no desire upon the part of the author to dictate what is and what is not proper building design. Let it further be understood that there is no intention to advocate that our architects should sacrifice art, utility or any other desirable feature of building construction in the interest of safety. But it is maintained—and this with a fair degree of conviction—that the architect of the future must combine safety, convenience, efficiency and art in order properly to serve the interests of society, with always—as in the case of the engineer—" Safety First."

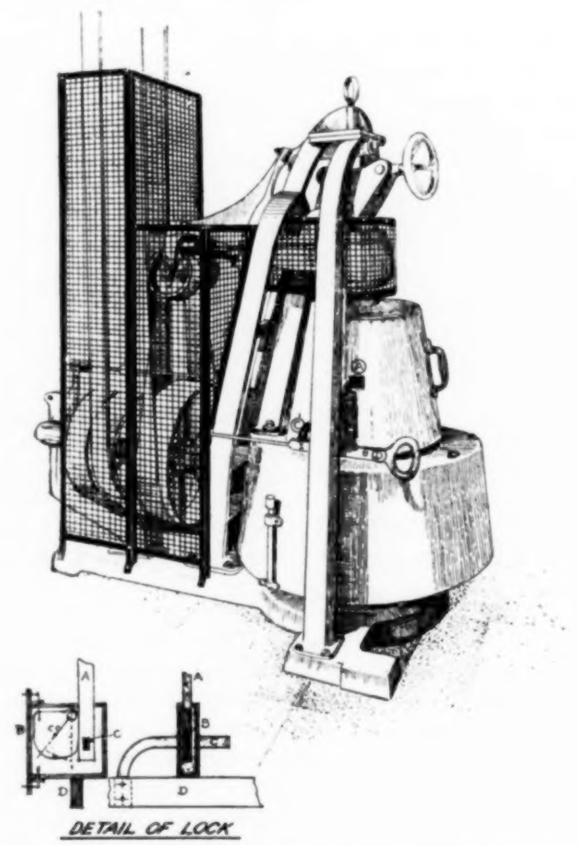


FIG. 7 DOOR-LOCK ON OVER-DRIVEN EXTRACTOR

Let it be further understood on the part of the author's brother engineers that no attempt is made or will be made on the part of the organization which he represents, namely, the Workmen's Compensation Service Bureau, to enter into specification details in any standards which that organization may be responsible for. In fact, the term "standard" as used under the auspices of that organization refers solely to standardization of principles, leaving it then to the engineers of the various industries to apply these principles in their particular field, a task for which they are far better qualified than anyone else.

The Workmen's Compensation Service Bureau, however, has a vital economic interest in the premises. It is an organization composed of the leading liability insurance companies on this continent. It deals with the matter in a concrete sense in so far as its constituent company members insure the liability occasioned by any hazard present in buildings and equipment. To value these hazards properly and to eliminate them, as well as to avoid discrimination, specific standardization is essential. We have undertaken it in the interest of our own business, but the interest is equally as great on the part of the industries insured because the rates for insurance are in direct ratio to the presence or absence of any hazard.

In conclusion, the author believes it a self-evident fact that the engineers as creators of our industries owe it as a duty to these industries and the nation of which they form so important a part to exert their utmost efforts in the conservation of life and property which are so essential to the economy of the individual plant and so essential to the nation as a whole. The subject should be treated with the consideration which some of us at least feel it justly deserves. Our methods for reducing waste, whether it be material or

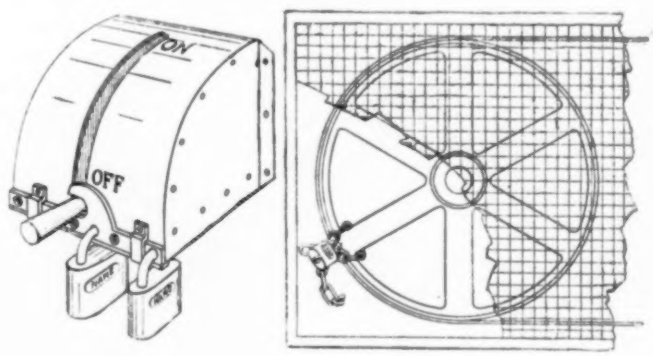


FIG. 8 TWO EXAMPLES OF PADLOCKS AS SAFEGUARDS

vital, must be improved through preventive methods and none is better fitted to lead such a movement than the engineers. It is not proposed that a new branch of engineering shall be established for this problem. The real object must be to make each branch of the engineering profession in the true sense of the word " Safety Engineering."

DISCUSSION

FREDERICK R. HUTTON. In the historic development of any productive industry, the first consideration had to be to make something that would do the work,—that was the condition from the seventies to the nineties. Then came the period of improving the efficiency with which the result was attained. In the early part of the twentieth century, the third stage was reached; that is the evolution takes the forms of, *first,* getting the result; *second,* getting it economically and efficiently, and *third,* getting it with safety to the men concerned.

Mr. Hansen has not mentioned what I know he very clearly sees, and that is that the most effective way for designing engineers to attain the desired results is by means of what is called the interlocking principle. In a laundry machine, for example, it should be impossible to shift the belt to start, until you have closed the machine and locked it, and got your hand out. It should be impossible to start the elevator until the door has been closed; correspondingly, it should be impossible to open the door until the elevator has been stopped.

Mr. Hansen has not referred to one unfailing method of securing safety, and that is that it should require the use of both hands to start a machine. If the operator must pull a

lever with the right hand and then pull a lever with his left, to either start or stop the machine, he has no hand free which he can get in the way of maiming forces.

Complementing the author's statement of basic principles, and his definition of "practical" safety devices, I would say that these devices must be such that they do not diminish production.

In closing, may I express my pleasure that the Society should have devoted a session at this meeting to the discussion of this most important subject. I have been interested in the subject of Safety since about 1895, when nobody thought much about safety engineering. I did not myself until it was brought to my attention that the practice in Europe was far ahead of our own. We are catching up, and it is to the credit of the engineer that this result should come

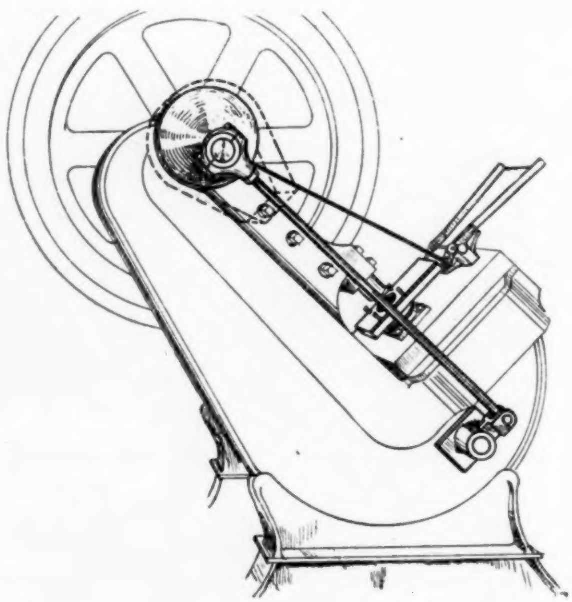


Fig. 9a Stamping Press Gravity Feed Cam-Actuated Ejector

about, and to organizations such as those of which Mr. Hansen is representative.

Frank E. Law contributed a written discussion, stating: I doubt whether safety standards should be absolute, should be hard and fast. It seems to me that there are often several ways of accomplishing a desirable end, and one way should not be adopted to the exclusion of others. All that should be necessary is that the particular way adopted will achieve the desired end. If some latitude is allowed in the choice of means, we can often secure the coöperation of a workman through his pride of authorship. A workman is much more likely to use willingly and effectively a guard devised by himself than one imposed upon him by authority. I think, therefore, that Mr. Hansen is proceeding along the right lines when he announces "that no attempt is made or will be made on the part of the organization which he represents, namely, the Workmen's Compensation Service Bureau, to enter into specification details in any standards which that organization may be responsible for. In fact, the term 'standard' as used under the auspices of that organization refers solely to standardization of principles, leaving it then to the engineers of the various industries to apply these principles in their particular field. . . ."

I would urge upon engineers the propriety and desirability of checking all designs of structures and machinery prepared in their offices from the safety standpoint, and when purchasing machinery to include safety requirements in the specifications.

I would express doubt as to the advisability, in legislating with regard to safety measures required of employers, of setting forth in detail the guards to be provided, but would instead recommend a statement of the principles, imposing upon the Commissioner of Labor the duty of issuing regulations covering the details.

It constitutes a distinct reproach to the engineer that he has done so little in the field of safety engineering. At the same time it is only fair to bear in mind that he has often been hampered by his employers and by the limitations imposed by competition and expense.

It is interesting to note, however, to what a considerable

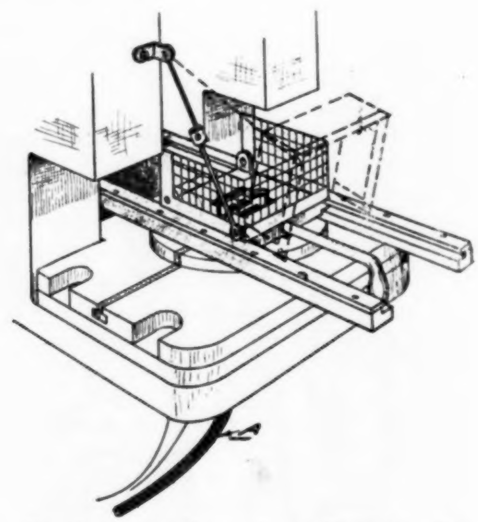


Fig. 9b Stamping Press Slide Feed Air Ejector
A = Air Ejector Hose

degree the work of the Society has had to do with things that lie within the realm of safety engineering. The design and construction of structures and machines to secure maximum strength, the choice of proper materials, is safety engineering. A large part of the work of the Boiler Code Committee had to do with the proper design and construction of boilers from the safety standpoint and the choice of proper steel for the shell, furnaces, stays, rivets, and other component parts. But there is much more that the members of the Society can do, and the field of subjects for papers dealing with safety problems is practically unlimited.

Safety engineering, unfortunately, like every other effort for betterment, often runs afoul the matter of expense. The expense of perfect design, materials, construction, conditions, is prohibitive. We have constantly to bear in mind, therefore, the distinction between what is desirable and what is feasible, having regard to the matter of expense. The problem of the engineer is to secure the maximum of safety at the minimum of cost. It is easy to wreck a promising safety programme on the rock of expense.

The insurance companies have done and are doing a great deal to help solve the problem of the prevention of accidents. They have published literature on the subject, have made and are making safety inspections, and have established service bureaus and inspection boards to make merit or schedule rating inspections for the purpose of determining discounts

and additions to the rates, as safety measures are or are not adopted by employers. The companies earnestly hope that they will have the full and complete coöperation of engineers everywhere in the great work of promoting industrial safety. Mistakes will be made at the outset, for we are doing pioneer work, but we hope these will be as few as possible, and we hope also that we shall have the benefit of constructive, not destructive, criticism of our friends and fellow-workers, the engineers.

John H. Barr (written). The author states that only those tools should be specified which have all possible safeguards embodied in original design. It may be difficult at the present day to get always the machine required with all danger points guarded in accordance with modern ideals, but the statement that safeguards *should* be included by the maker and as a part of the original design is absolutely sound. Not only on aesthetic considerations, but in the interests of effectiveness and true economy should this be done. Until builders generally adopt the practice of supplying "built in" safeguards (and for some years afterwards while old machines are still in action) the poultry netting, picket fence and ashcan types of makeshifts will persist in offending the eye. It is not necessary to dwell on the unsightliness of these contraptions, much as we may rejoice to see them where no protection previously existed. In many cases they are not as effective as would be well-considered designs made in the shops of the builders.

It is, however, the consideration of real economy which may be expected to make consistent well designed safeguards the rule rather than the exception. In the first place, the introduction of the "merit rating system" will be an incentive to purchasers to call for all necessary safeguards with the original purchase. The history of factory fire insurance proves that owners will respond to higher requirements when convinced that there "is money in it." When purchasing agents show a preference to the bidder whose product has these features properly incorporated, the seller will begin to take notice.

I believe the progressive builder is disposed to anticipate such demands and that he would voluntarily go much further in the matter than he has yet done if there were adequate assurance that *any* design he can offer will meet the statutory requirements, the insurance standards and the idiosyncracies of inspectors wherever his product is sold. At present, unfortunately, he has no such assurance. The chaotic condition of today must be remedied before the situation can become really satisfactory.

Such work as that done by the National Machine Tool Builders Association, the Abrasive Wheel Manufacturers and the Machine Shop Practice Committee of this Society on the Safety Code for the Use and Care of Abrasive Wheels will have great influence on legislation in the various states and will tend strongly toward uniformity of requirements.

In a letter to the sub-committee of this Society on Protection of Industrial Workers, Dr. S. W. Stratton, director of the U. S. Bureau of Standards, said:

> We are in entire sympathy with your feeling that the great obstacle to the adoption of more complete standardization from the safety standpoint by manufacturers, is the diversity of requirements and the conflict with existing regulations in different sections of the country and even by different jurisdictions in the same territory.

This statement sums up the matter quite conclusively.

Adequate, yet reasonable and practicable codes, generally acceptable to all interests, must be worked out for each class of mechanical equipment. If this work is well done, it is not unreasonable to expect that eventually it may be generally adopted. While other organizations may be better adapted to promote the important work of safety propaganda and while the prosecution of various phases may be properly left to different agencies, it is believed that this Society is peculiarly called upon to take a leading part in formulating several of these standard codes and in exerting its influence toward securing their adoption throughout the United States.

John W. Irwin[1] (written). The effort to standardize safeguards would be more immediately effective if there could be devised some way to show manufacturers the waste resulting from lack of standards. There are so many men who have their own ways of doing things, and who are unwilling to look about them and see what has already been done by others. Many know the end to be attained and have a general idea of how to reach it, but have neither the knowledge nor the equipment of the organizations which specialize on the subject.

The matter of mechanical safeguards and their standardization is an engineering question in the sense brought out in the paper, but the profession can render a further service for industrial safety. Engineers can develop methods of guarding, but they can also be teachers and leaders. They can disseminate information about what has already been done. They can utilize countless opportunities of pointing out the waste of experimental, haphazard safeguarding.

The waste from ignorance in guarding is not to be compared with the cost of industrial accidents, but it is sufficiently large to warrant the attention both of engineers and safety men generally. This waste may be reduced, and gradually eliminated, by concerted action on the part of all who come in contact with people who are trying to find their own ways of doing things that have already been successfully accomplished.

The desirability of standards is quite sufficiently obvious. The thing that is now needed is a widespread knowledge that a long step in standardization has already been taken. I refer to the Universal Safety Standards as already developed by the author and his associates.

Our company takes the attitude that mechanical safeguards constitute the beginning of accident prevention; and the education of the workmen towards the elimination of accidents resulting from ignorance and carelessness is of equal, if not of more importance.

We have found that safety work as a whole must comprise the application of mechanical guards, the elimination of such general hazards as may exist in a plant, and then a systematic, progressive, never-ending campaign to develop the minds of the men in the direction of safety—of carefulness through force of habit.

The men must be reached by varying methods. Frequently, general welfare work, plant sanitation, social features and the like, are effective in proving good faith on the part of employer, and bringing the men to believe that the influences for safety are for their own good.

An educational plan cannot be operated until the matter of mechanical guards has been covered. You, as an employer, cannot consistently ask and require that your employees exercise caution, and cultivate the spirit of universal safety, until you have proved your good intentions by doing what you can to make accidents impossible. In a recent issue of a prominent magazine an illustration showed a workman operating a machine bearing a placard: "Think Safety"—a flywheel re-

[1] Vice-Pres. and Secretary, Universal Safety Standards Co.

volved within a foot of the operator's head, and it was not guarded; there were no belt guards visible, and exposed gears were easily discernible in the picture. This merely shows that there are multitudes of little things, and big things too, yet to be learned, both by the average plant operator and by the one supposed to know better.

No better "Safety Method" can be conceived than an ideal combination of high engineering skill, 100-point common sense, and the experience of the successful teacher. The devising of efficient guards, removal of building hazards, and the like, are engineering subjects purely. What we urge upon all engineers is to go further than that, and lend influence, example, and earnest coöperation in extending the work beyond the point of engineering as such, thus advancing the ideal condition where there is no machine unguarded, no unprotected building hazard, and where every workman knows what to do to protect himself and his fellows—and invariably does it.

W. M. KIDDER contributed a written discussion, stating that opposition to measures intended to prevent accidents arises from self-interest both of workers and of those in authority over them.

The owner, the stockholder, fears in the compulsory adoption of accident preventive appliances and measures a new drain upon the earnings of his business. Nevertheless, he may become a powerful ally of this latest move toward industrial efficiency when he realizes the practical economy of accident prevention in the long run.

To every serious accident there are many minor ones and each represents an interruption of industry—idle machines while fellow workers aid the injured one, damage to product, damage to machinery, and often a gang or a department thrown out of balance by the absence of an essential worker. These things do not merely add to the difficulties of the foreman in charge and of his superintendent; they cost the stockholder money. Just so far as he realizes this will he desire accident prevention, because it increases his profits by decreasing their impairment.

If the possible potent aid of the stockholder is utilized by engineers and a broad view is taken of the commercial aspect of the standardization of safety principles, the added impetus of this powerful influence will lighten the task of the engineer and leave him the more free to deal with the technical side of the matter, which holds quite enough problems to engage his best energies.

DAVID S. BEYER[1] (written). The author, in stating that the real goal must be to make each branch of the engineering profession Safety Engineering, has established a motto which might well hang over the desk of every engineer in the country. It is a primary duty of the engineer to eliminate needless expense and waste, and during the past few years it has been shown conclusively that one of the most appalling wastes in industry is that caused by preventable accidents.

The most effective time to prevent accidents is when the construction drawings are being evolved under the pencil of the engineer. Then the erasure of a line, or a few additional strokes of the pencil, may mean the saving of a human life or the elimination of hundreds of dollars of unnecessary expense in making changes later.

It might be said that there are two equal doors to the House of Safety, the first marked Mechanical Safeguards, the second Safety Education. The engineer has always held the key to the former through his control of the design and construction of new buildings and machinery. This phase of his work is usually most prominent in our minds, and I notice Mr. Hansen has confined his remarks to it. The attitude of the man who runs a machine is just as important, however, from the standpoint of accident prevention, as the condition of the machine. On account of the ever-increasing influx of engineers into all industrial lines and the fact that executive positions are being filled more and more by men of engineering training, the matter of safety education of employees should accordingly be mentioned as a vital form of standardizing safety principles.

The safety organization has become an integral part of the working organization of hundreds of our foremost industrial plants, and the knowledge of how to organize the working force for safety and how to interest the employees in accident prevention is an essential part of the engineer's equipment, if he aspires to the largest fields of usefulness.

[1] Mgr. Accident Prevention Dept., Mass. Employees Insurance Assn.

JAMES O. GIBBONS (written). One of the most interesting points brought out in this paper is that safety should be considered as an essential element of good engineering design, rather than as something to be added just because the customer or the law demands it. Of course this idea has been gaining ground for some time, but if it can be shown that the liability of a machine to cause injury calls for an actual cash charge against it as insurance of the risk, we are putting safety efficiency on the same plane as production efficiency.

As has been pointed out, the loss to the community through preventable injuries is very great. It is perhaps not quite so easy to show just what the loss to the individual employer is, because in addition to the time taken laying off for recovery, there is the moral effect produced by accidents, the effect of which on efficiency is hard to estimate.

Knowledge on this subject of safety is a great help, because however much we may wish to do the right thing for its own sake, the surest way to put safety on a sound foundation is to show that it pays as a business proposition.

GEO. M. PRICE[1] (written). I regard this movement for the standardization of safety principles by safety engineers as one in the right direction and an important advance in the safety and sanitation of industrial establishments. Your society and the Workmen's Compensation Bureau are doing what the German Trade Associations have been doing for a great many years, and the results of such standards of safety devices, etc., are bound to be a great improvement in the safeguarding of the workers' lives and limbs in factories and workshops.

May I not suggest that there is also a great need in extending the standards not only to safeguards and safety devices, but also to the sanitation and general hygienic environment in industrial establishments. May I also make the suggestion that your Society endeavor to introduce the study of safety engineering in the various technical and engineering schools so that the future managers and heads of industrial establishments should be fully prepared to put into practice all possible safety devices for protection of workers.

Another suggestion would be that the description of safety devices should be couched in a simple and, if possible, nontechnical language so that the workers and mechanics may be able to understand them and put them into practice.

THE AUTHOR. I desire to express my appreciation of the interest which my paper has created, as indicated by the discussion.

[1] Director, Joint Board of Sanitary Control, New York.

MODERN MOVEMENT FOR SAFETY FROM STANDPOINT OF MANUFACTURER

BY MELVILLE W. MIX, MISHAWAKA, IND.

Member of the Society

THE successful salesman is the man who first sells himself on his proposition, who becomes so saturated with its merits, so enthusiastic in his beliefs that conviction is automatically transmitted to the buyer. Substantially the same principle holds with the modern safety movement; no manufacturer will make real progress in the movement until he takes a personal interest in it, and is able to transfer his enthusiasm and earnestness to those directly in charge of work and, through them, in turn, to the workers themselves. A form of evangelism is required that arouses the spirit of all concerned.

In these days of Workmen's Compensation and high damage awards in employer's liability suits, the manufacturer will not be slow to grasp the main idea that "saving is earning," and act accordingly. He will find that the market is full of "guards" of all kinds for all sorts of protecting purposes and places, and a large supply of propaganda calculated to encourage him to spend money in an endless way on preventive appliances. He will find an army of inspectors ready and active with unlimited recommendations and orders for every machine and for every nook and corner of his factory. He may be pursuaded to buy them all and to protect without limit, but if he is not himself converted to their efficiency and need, and if he has not the coöperation in spirit of his employees, foremen and superintendents, his financial investment in them counts for little.

In no place is there a better or more practical way to develop the "save my pal" movement than in a factory or mill. Not only must the worker look out for himself, but his every thought, when engaged in hazardous work involving operations with which others have to do, must be "how about my fellow worker?" When in a factory organization such thoughts become automatic from president to "sweep," then money spent for guards becomes a real capital investment; but without that spirit its principle effectiveness is to expand the inventory and keep up the insurance rates.

We spend thousands of dollars in fire protection in order to reduce the hazard and save in operating expenses. We drill our factory fire brigades without thought of the cost, because we are educated by actual experience to realize what such losses mean in actual money and stoppage to business. It has taken years to learn the lesson, but we have done so, and fire protection is a recognized essential part of wise business administration. We do not stop at the installation of fire prevention appliances, but we put them under constant, careful inspection; we instruct every man in their location and uses; we leave no stone unturned to insure the effectiveness of the apparatus when called upon.

But, with safety "guards," until we can see the same benefits in providing the same relative protection to the individual, until we can bring him to see how it affects him physically and financially to "keep right with the guards," we fail to realize the full benefit of the investment of money and time spent in education. As a concrete example of what may be accomplished in this direction, I give here figures (Table 1) showing the experience for the past five years of the company with which I am associated.

A wage bonus of two days' extra pay for all men in a department having a perfect score for one year was based on the general effect of a cash bonus, but more particularly on the fact that a man will do for the benefit of the gang or department what he would consider beneath his dignity to do to safeguard himself against minor accidents.

We have numerous cases on record where men have cautioned each other with the admonition that such recklessness would endanger the standing of the department. One instance where a foolish act of one man lost two days' pay for a whole department has proven a wonderful object lesson to the entire plant.

In these days of scientific management and administration, there may be a tendency to the thought that, as such things do not seem to show immediate cash credits on the balance sheet, their importance may be set back for the moment for motion studies, rewards on operations, etc., but there is no economy in tolerating a condition that may require new men to be broken in to replace those impairments which a little time spent in educating men and in arousing them to the Safety First pitch might have avoided. It is impossible to place a money value on a pair of eyes, a leg or an arm; and while the expression "the human scrap heap" displeases us, we must know that there is such a thing, and that the right word at the right time may be effective in saving a fellow worker from that untimely and unseemly misfortune.

TABLE 1 COST OF ACCIDENTS COMPARED WITH PAYROLL, AND TIME LOST COMPARED WITH TIME WORKED

FIVE YEAR RECORD

Year	1910	1911	1912	1913	1914
Total cost of accidents for each one hundred dollars of annual payroll, including first aid, hospital, bills and claims, if any..	\$0.503	\$0.228	Score board adopted \$0.112	Score board in use. Actual cost \$0.079	Score board in use. \$0.070
Time lost due to accidents beyond the fraction of the first day. Percentage of number of men-days lost to the total number of men-days worked....	No record kept	No record kept	Fraction of 1 per cent 0.394	Fraction of 1 per cent 0.1924	Fraction of 1 per cent 0.1165

Why not be practical and do all we can whenever we can to prolong the usefulness from the physical standpoint, if from no other, or every man or woman that we employ. Experience has developed that guards are not especially effective if, with them, we do not have the coöperation of the workman. If we make things automatically safe, we are quite as apt to do the worker an injustice in weakening his own spirit of self-preservation. Workers must recognize danger—they must respect it, and be ever watchful in every phase of life as well as when at work. The family must have it drilled into them; schools must preach and teach it; the citizen must be a party to the campaign of education, as only in that way may we be assured that the practice of "Thinking First" comes before Safety First.

Out of 30,000,000 male workers in the United States, about 7,250,000 are engaged in the general manufacturing lines. The annual loss due to fatal accidents is about one to four thousand, the lowest of the eighteen principal occupational groups; yet from the standpoint of public attention, the manufacturer is held up before the public as the cause of

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nearly all of the physical suffering and loss due to occupational disaster.

This situation would not exist if the manufacturer were more personally interested and inclined to fight for his rights and a proper recognition of his standing on the score board of national employment. Out of 22,500 fatal accidents in 1913, only 1819 are attributed to the manufacturing occupations—comparatively small indeed. Yet it can be much smaller if we will only approach the subject from the personal standpoint, evangelize with our employees, and arouse in them a spirit of coöperation and thoughtful, prudent regard for themselves and their fellow workers that will be automatic, and a habit for protection and carefulness, of which they cannot break themselves even if they should wish to. That is the manufacturer's work today.

Numerous plans have been devised for arousing and maintaining this personal interest; score boards, bonuses, special favors to winners, lectures, moving pictures and many other plans are being used. To the extent that a management believes in these plans and encourages their uses, just to that extent will it be rewarded with the association of an unimpaired, efficient organization of contented, prosperous workers.

DISCUSSION

LUTHER D. BURLINGAME agreed that while we are giving attention to the matter of guarding and protecting our machinery and buildings, we should give equal, if not greater, attention to engendering the spirit of safety among our employees, and should consider the various means which can be used to develop the safety habit among the workmen.

He was not fully in accord with the author as to the statement that putting guards on machines might make the workmen lax in regard to safety matters, and therefore increase the hazards rather than otherwise. He believed we should do all the guarding possible, and protect the machines as fully as possible. Even then there will be hazards enough to keep the workman alert and make it advisable to preach safety in the organization, and preach it so hard that the spirit of the workman shall be that a part of his value lies in working in a safe way, and that the spirit of the foreman shall be that a part of his value lies in seeing that his workmen work in a safe way.

FREDERICK R. HUTTON. I would like to contribute something to the statement that "a man will do for the benefit of the gang or department what he would consider beneath his dignity to do to safeguard himself against minor accidents." There is a splendid philosophy in that sentence. The difficulty with many of us is that we are inclined to take the position that we are immune from accidents which might befall someone else less fortunate. If, therefore, we can safeguard the less gifted alongside of ourselves and make that protection our responsibility, we shall have done a great deal in securing safety.

To this end, I would like to emphasize the creation among the working people themselves of committees of safety. After a workman has served on such a committee, and has himself seen the philosophy and importance of the habit of safety, he will not only find it very much easier to protect his reckless neighbor, but he himself will not offend. He will keep himself from doing that which, as a member of the safety committee and serving to prevent accidents for a week, or for a month, he was called upon in an administrative way to prevent in someone else.

FRANK E. LAW emphasized the point that securing the coöperation of the workmen was often more important in preventing accidents than installing safety devices. He instanced the case of a large manufacturing corporation which had spent upwards of five million dollars in safety work. It had been estimated that not more than fifteen per cent of this vast sum had been *directly* effective in preventing accidents, but the money had been well spent because the expenditure resulted in securing the coöperation of the workmen. When the employer himself does all that is reasonably possible, he is pretty certain to evoke coöperative response from his employees.

JOHN H. BARR fully agreed that the importance of the educational work is frequently greater than that of merely providing guards. He said, however, that the Committee on Protection of Industrial Workers had decided its work should be confined, at least for the present, to an attempt to develop and bring about the adoption of standard Safety Codes, because so many other organizations and agencies are working very effectively on the educational side.

The influence of this Society, he believed, would help in the adoption of such standards, whereas other organizations have made a specialty of propaganda work. He said the committee is fully in sympathy with this work and desires to coöperate, but it has selected what is conceded to be the narrower field, because it seemed to be the one in which it can work with the best effect at the present time.

CARL M. HANSEN said that the standardization of the human equation is a factor he did not believe anybody was able to cope with. He thought we should confine ourselves as nearly as possible to mechanical details of safeguarding.

LEONARD WALDO said that he had noticed that in some of the great steel works the safety first idea has so permeated the administrative staff and the men that you will find notices constantly posted for semi-weekly, weekly and bi-monthly meetings on safety subjects. Prizes are offered for the best safety work; certain men are appointed to supervise safety matters around the different parts of the plant; highly organized hospitals are established, and there is a wonderful movement on the part of the intelligent control of great works towards safety among operatives.

A bad accident almost invariably occurs because the sense of danger is not present, on account of some new modification or some novelty of the process. If we codify our rules of safety, we have been of the greatest possible help to the administration of the Safety First movement.

In all our occupations new forces are coming into use every day; in regard to these new forces there is no explanation or codification of what the possible dangers are, and many people are injured.

F. D. PATTERSON[1] said that from the standpoint of manufacturing, safety paid dividends not only in dollars and cents, but also as a matter of fact in added happiness to every employee, by the prevention of industrial accidents.

He dwelt on his experience at the plants with which he is connected, showing that before active safety work was undertaken the accident curves were mounting upwards, but upon adoption of safety measures, these plants not only had their experienced men saved from injury and available for productive labor, but thereby avoided the necessity of having inexperienced workmen laboring in their place; and he em-

[1] Director, Dept. Sanitation & Accident Prevention, Harrison Bros., Philadelphia.

phasized the fact that from the accident standpoint the new employees form one of the perils of modern industry.

He considered that the work in accident prevention in industrial plants comprises two distinct features:

a Guarding of all accident hazards by mechanical guards which will reduce the number of accidents approximately 20 per cent.

b A campaign of education bringing home to every workman the facts that he is personally responsible for the accidents that occur and that he ought to constitute himself a safety committee of one to see that accidents do not occur either to himself or to his fellow employees.

THE ATTITUDE OF THE EMPLOYER TOWARDS ACCIDENT PREVENTION AND WORKMEN'S COMPENSATION

BY W. H. CAMERON,[1] CHICAGO, ILL.

Non-Member

THERE was a time when workmen were expected to assume the hazards of their work, and employers, through insurance companies, paid as little as possible for accidental injuries or death. In one State only seven deaths in the hundred were paid for. Employers were not inhuman—workmen were careless or reckless and simply suffered for their foolishness.

This condition has changed. In thirty States the democracy has said that the financial burden shall be borne by the industry. This meant social and industrial revolution. Many employers predicted that the whole movement was a transient outburst of humanitarianism and that it would die out in the course of time, just as fashions in clothes changed. There were others, however, who had an overwhelming sense of the safety movement, who realized that it spelled industrial efficiency and justice and was a symptom of progress in civilization.

The census reports do not show the number of employers for or against Workmen's Compensation Laws, or industrial safety measures, but a radical transformation in relationships to this problem has brought about many and varying attitudes towards it. This paper is an attempt to interpret these tendencies in as unbiased a manner as possible.

Interest in accident prevention is not new. For many years our Government has been a leader in providing a measure of protection for mariners through the lighthouse and life saving services, the Interstate Commerce Commission has ordered the use of certain safety appliances for railroad cars, and other agencies have contributed to the general movement.

About twelve years ago, however, America began to realize that preventable industrial accidents were a national evil of appalling magnitude. The agitation for Workmen's Compensation Laws brought forth astounding facts and figures. It was shown that both the number of accidents and the economic losses occasioned by them were increasing in ratio more rapidly than the output of our industries, but it was not until the extent of the evil became fully apparent that the safety campaign began.

For many years labor unions had demanded safeguards for machinery, and we had on our statute books various kinds of safety requirements, which, though perfunctorily observed, were not really enforced. As soon, however, as Workmen's Compensation Laws transferred the burden of industrial accidents from the workman to the industry, the "Safety First" movement began. Mention should be made, however, of some of the large corporations who had "seen the light" several years previously, and had voluntarily taken decisive steps not only to safeguard their employees, but to compensate every injured workman.

Under the stimulation of self-interest, national commissions, Governmental bureaus, employers' organizations and chambers of commerce began a serious study of the causes of accidents and a possible means of preventing them—the methods of minimizing the losses from accidents. Finally, there has resulted a full and free interchange of ideas through various engineering and industrial organizations and through the National Safety Council, which has made the work immensely more effective.

The effects of this work were another triumph for method when applied to the social and industrial question. The work had previously been done in a haphazard and unscientific way, and was, in consequence, very unsatisfactory.

It should be further stated that it was commonly assumed that the rapid increase in industrial accidents was inevitably caused by the growing use of power driven machinery. This view has been shown to be far from the truth, because the majority of industrial accidents are not caused so much by machinery as by carelessness in its use—carelessness proven to be very largely preventable through extensive and thorough educational methods. The employee "took chances" and the employer expressed his attitude on the subject by the slogan: "Get out the work." The man who received his approbation was the man who "did things" and accidents were accepted as part of the price of success. This fallacy had to be very obvious before it was exploded.

This attitude of mind was reflected in the state of the law, which held that while the employer was bound to carry on his work in a reasonably safe manner, in a reasonably safe place, with reasonably safe tools and reasonably safe workmen, reasonable safety did not require him to take undue precautions, the hazard being put on the workmen through the three archaic common law defenses, viz., the fellow servant doctrine, acceptance of risk, and contributory negligence. In other words, the employer was not bound to abolish the danger spots even if they were vital to production, and did not place him outside of the "reasonableness" test. The common law held that the employer was not under any obligation to provide guards, unless they were required by a special statute. The real cause of the acceptance and growth of accidents was the general and philosophical acceptance on the part of both employers and workmen that nearly all accidents were due to the "human equation" and an inevitable part of the business, and that it was impracticable to guard against or prevent them. There was no true appreciation of the causes of accidents, and, therefore, no logical plan put forward as a remedy.

The first step in accident prevention was to disprove this doctrine and to show that accidents were unnecessary. This could only be done by serious study of the causes of accidents, and a willingness to invest time, money and brains in remedial methods. Sentiment may make men anxious to abolish accidents, but "self interest" spurs them on to collect and classify accident statistics, to hire competent engineers to devise methods of accident prevention, and to spend a

[1] Secretary, National Safety Council.

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great deal of money in making these methods productive. That is why effective safety work coincided with the introduction of Workmen's Compensation Laws. Credit should be given, however, to the concurrent growth of a larger belief in the doctrine of fellowship; and feeling of responsibility for the welfare of their men on the part of a large number of employers has been a powerful adjunct to the force of necessity in bringing activity to a focus.

It was also feared that if machinery could be safeguarded, or changed in character, or operated at lower speed, economic operation of industry would be interfered with. This, too, has happily been proven untrue, for good safety work has been found the partner and part of efficiency; for, being simply the study of the right and orderly way to do things, it has aided shop methods and economy in a very marked degree. Safety work has, therefore, evolved as a great constructive economic force in industry, as well as a social and humanitarian one.

What then is the present attitude of employers toward effective methods for reducing industrial accidents, and paying for every personal injury suffered by workmen under Workmen's Compensation Laws.

The ultra-conservative type of employer is not yet awake to the modern methods of accomplishing results. He is often the man who has come up from the ranks, or the one who has inherited the established customs of his forefathers—the employer who feels that he only gets as much work out of a man as he can force out of him—that industry is a struggle between two men as to who will get the "best of the bargain." This type of employer has not taken kindly to the suggestion of his responsibility for safe methods of doing work in his shop. His attitude is that he owns the business—that he has the exclusive privilege of directing it, and the suggestion that his foremen or workmen be asked to tell him where the dangers of the business may lie is obnoxious to him and wrong in principle. He is afraid that if his workmen are organized into accident prevention committees this will encourage the union idea among his men. The Workmen's Compensation Law forces this type of employer to study more carefully the causes of accidents suffered by his employes, and because he has to pay the cost of the accidents he may be converted and study the results secured by other employers through more humane measures. He will first have to learn to do business by the coöperative method, and if he wants to eliminate the excessive cost of accidents he must realize that his employees should be recognized as having a part in the organized plan to eliminate accidents. He must be willing to educate his workmen in safe practices—the right way of doing things—to study their operation of the work in his shop from the standpoint of safety, and make his workmen understand that "Safety must be the first consideration."

A second group of employers may be said to occupy the "middle ground." These are the employers owning modernly constructed plants, well ventilated and illuminated and clean and orderly—and who take a moderate interest in the safeguarding of machinery, if it does not cost too much money—but who do not believe in "new-fangled notions." This employer is shocked by the horrible details of an accident, but considers himself to be a model of propriety in his own personal relationships. He would resent any insinuation that he was not vitally interested in the welfare of his employees. At the same time he is rather slow to accept new conditions—he believes in all the rights of the "boss." He is averse to publicity methods concerning accidents; he dislikes criticism or any intimation that there may be anything wrong with the operation of his plant. A large percentage of the owners of small plants may be included in this category. This applies particularly to employers whose businesses are not generally considered to be of an especially dangerous character. Employers in this group have not actively opposed Workmen's Compensation Laws but are apt to support associations who boost propaganda against radical legislation.

The attitude of the third group may be termed that of the progressive type—the pioneers in the accident prevention movement. The large employers of labor, the leaders in industrial life, and the employer who is himself working earnestly for the welfare of the race, are among those who have taken the lead in making an effort to solve the accident prevention problem. They are in favor of a fair and equitable Workmen's Compensation Law. They have equipped their plants with sanitary toilets, locker facilities, modern washrooms and recreation centers, and do everything within their means to make their work places attractive and comfortable.

This class of employers asks safety engineers to review plans for new shop buildings from the standpoint of safety and comfortable working conditions. Tacitly they confess to their employees that they may not have done their full duty towards them in the past in providing safe working conditions, and urge coöperation by encouraging the men to work with them in establishing safe working practices to eliminate as many of the hazards of the industry as may be possible. They organize their workmen into committees for the purpose of getting their suggestions in making conditions safe, and carry on a vigorous educational campaign to teach the workmen the real causes and remedies for accidents. These are the employers who reduce accidents in their plants from 25 to 85 per cent, and whose efficiency account shows savings up to many million dollars per year. These employers unanimously declare that results are securable from safety work commensurate with the time and effort put into the task. One of them has recently stated that his investment for safety has brough a tangible return of 80 per cent.

The increase in insurance rates for protection from liability under workmen's compensation has brought about a revision in the methods of establishing premium rates, and now, through the (so-called) "merit rating system," this group of employers realizes the benefits of making their plants safe.

To summarize, from the anciently accepted attitude of indifferent or ignorant acquiescence in accidents has come:

I An awakening, caused by
- *a* publicity that has compelled a realization of the inhumanity and fearful economic waste of accidents
- *b* the discovery and growing conviction that accidents are preventable

II The employer has proceeded to prevent accidents
- *a* impelled by his humanitarian impulses
- *b* spurred by compensation laws that put the burden and responsibility on the industry and employer, and sweeping away the old outgrown customs and laws

III The result has been
- *a* a great and gratifying reduction of accidents through mechanical safeguarding and education of workmen
- *b* the discovery that good safety work has been a big money saver over the old accident conditions
- *c* the discovery of the great constructive value of safety work, it proving to be a study of the proper way to accomplish manufacturing results and, therefore, a great aid to industrial efficiency and economy

d the bringing of employer and employee together on a common ground of mutual interest, thus producing a fellowship and good feeling and coöperation in industry that nothing else could have accomplished.

Aside from the attitude of the three groups of employers referred to, it should be stated in all fairness that when the history of the safety movement is written a great deal of credit will be given to the employer. It has been due to his study and interest that the cause of accident prevention has grown to immense proportions in an amazingly short time.

No better evidence could be given of the attitude of employers toward real interest in accident prevention than the development and growth of the National Safety Council. The council was organized by a group of representative employers as the result of a safety meeting held in Milwaukee in 1912. The headquarters of the council were not opened until October 1913, but within a period of two years this organization has secured a membership of over 1600 employers, representing 150 industries, included within which are 5500 representatives located in every State of the Union, except two, and in many foreign countries. These employers have voluntarily joined the council for the purpose of formulating information to promote the cause of accident prevention. Through the dissemination of the collective experience of the members of the council of various methods adopted to eliminate accidents, a great deal of light has been thrown upon these problems. The National Safety Council has organized twenty-three active local councils in various parts of the country from San Francisco to Boston. The Fourth Annual Congress was attended by over 1500 employers, or their representatives, and for attention and interest this meeting has rarely been excelled.

Some employers predict the most far-reaching effect from the safety organization plan in bringing the employer and employee together into closer relationship, by obliterating the class feeling which has kept employer and employee apart. When both sit down at a safety meeting to discuss a problem of common interest, there is apt to grow up a better understanding of the aims and purposes of each party. If the employee has imagined in the past that the employer's indifference has been the cause of accidents, he soon learns that the remedy lies principally within himself.

While it is realized that many employers are not yet in sympathy with many of the aspects of the accident prevention problem, and that the Workmen's Compensation Laws are defective in many ways, it is believed that both employer and employee will profit by the new status of the work and will gain a new and better view of their industrial obligations.

DISCUSSION

John Price Jackson. I believe that this paper is a clear review of the attitude of the employer in Pennsylvania toward safety, and the work that is being done. From the point of view of safety legislation, the situation to-day is that practically every State in the Union now has something in the nature of what may be called an Industrial Board. In many cases there are obligatory laws which are enforced by these Boards and the accompanying inspection forces, but many of these laws are often imperfect and without uniformity over the whole country. Suppose Pennsylvania, through its Board, calls for a certain kind of guarded lathes, and Illinois calls for another kind, and Indiana for a third kind, then undoubtedly waste and useless expense is involved. There are a great many kinds of machinery where a great many types of guards can be used, and therefore, where the Boards can make a great differentiation and cause unnecessary lack of uniformity by specific requirement.

If such a body as this Society, through its Committee on Protection of Industrial Workers, can put on record a reasonably sound practice for providing all of our industrial machinery with safety devices, then the Boards, instead of making haphazard rules and regulations, may be guided to make rules according to this practice.

We have another group of laws growing up—compensation laws—which have been adopted in nearly every State. Under these laws an employer who saves human loss of life and capacity as carefully as he now saves fuel loss, is actually going to save many dollars in his actual outlay, and also in his insurance rate.

There is a very material opportunity for financial saving by having available acceptable practices for the installation of safeguards and safety devices.

The subject of safety organizations and safety methods, though more a matter of management than design, is of even greater importance than that of safeguards. It should, therefore, have the careful consideration of this Society in order that the best methods may be outlined for the development of carefulness on the part of all connected with an industry.

Summarizing, my thought is that this Society of the Industries, with the help of its whole membership, should put on record conclusions and opinions which will be the directive force in the safety movement, and will keep this movement in the right direction, both as to the laws that may be passed in the several States, and as to the methods that may be used by the manufacturers themselves, and by the Industrial Boards and safety and inspection officers.

Charles Whiting Baker. In the general discussion of safety, a fact which is often ignored, is that safety is always a relative term, and that there is no such thing as absolute safety.

We cannot prevent all accidents, but what we can do is to make reasonable requirements that will raise our standards of safety. The question then arises as to where shall we draw the line. This is a matter which can only be determined by the engineer from experience and expert knowledge.

There is another serious side of this subject, and that is the question of fixing responsibility for accidents. As engineers, we should always remember to have some charity for the men who are responsible. It very often happens that the accidents which occur may have come from some cause for which any of us might have been responsible. Ignorance of some of the simple principles of physics on the part of some of the wisest is sometimes responsible for serious accidents.

Lew Russell Palmer. The engineer is playing a greater part every day in the work of accident prevention. Engineers, as a rule, stand for efficiency. There is nothing that indicates inefficiency in such a marked degree as a useless waste in human energy. Plant managements woke up several years ago to the fact that they could produce double the amount of material with the same number of men if they installed proper appliances and safeguards. Safety work is another application of the efficiency idea.

Mr. Cameron states that cooperation is the keynote of the work, and we need cooperation, both from safety organizations and State and National organizations of engineers.

STANDARDIZATION OF POWER PLANT OPERATING COSTS

BY WALTER N. POLAKOV, STAMFORD, CONN.

Member of the Society

THE aim of this paper is to outline the principle for a method by which the owners of power plants can, without the necessity of going themselves into technical details of operation, judge how close the actual performance of the plant is to the possible minimum cost at any time or under any circumstances, all variable factors beyond operating control being automatically adjusted.

THE cost of manufacture of power or any other commodity, being a result of numerous factors involved in production, is in final count the chief criterion upon which the market price, range of use, legislation, future developments, social welfare, etc., are depending. Few if any of these questions can be intelligently answered from the knowledge of actual costs, owing to the effect of an unknown factor—degree of perfection of the actual performance. The importance of an accurate knowledge of the meaning and significance of actual cost data to the financier warrants the development of a method whereby a cost report tells:

a What the power costs
b What it should cost
c Where the loss has occurred
d Why the loss has occurred

These questions answered, elimination of waste is a comparatively simple engineering problem.

Standardization and predetermination of cost of power production have never before been considered as possible undertakings, and their advantages were thought questionable. Predetermination of operating costs has not been made use of for other than estimates of probable future expenses prepared by promoters or contractors. These estimates are usually based, as is always the case in work of such nature, either on past performances modified by expectations, or on data obtained from actual performance of another plant considered as similar. The accuracy of such estimates depends at least on the following conditions:

a How reliable were the cost records used
b How near the possibilities were realized
c How close is the similarity of the equipment of plants under consideration
d What effect the location has
e What effect the nature of load has
f What effect the labor market produces
g How completely the future factors were foreseen

Since there is, however, no assurance that in the *sample plant* the operating methods are perfect, neither is it reasonable to expect that another plant is in every respect identical to the *sample plant,* and the value of such guessed operating cost is highly problematic.

Realizing, on the other hand, that such estimates are inevitably colored by the personal sympathies and prejudices of the estimator, a demand for a class of disinterested counsellors has been created. As the financial and not the thermodynamic side of the question is more vital in the eyes of the investors, the predetermination of results of power production is often entrusted to public accountants who may or may not be fully equipped to account thoroughly for the influence of such factors as chemical and physical properties of available fuels on efficiency of boilers and furnaces, effect of load and machine factors, water rate of turbines under predominating condition of load, role of power factor, wattless current, phenomenæ of electric transformation, transmission, drop of voltage in distributing lines and numberless other factors affecting the cost of current either directly or indirectly.

PREVIOUS EFFORTS TOWARD STANDARDIZATION

Urgent need of dependable measure for financial efficiency of operation prompted managers and owners to compare their operating cost data with those available from other plants. An attempt to form an opinion whether one's operation is as economical as possible by comparison with operating data from other plants whose equipment and service is more or less radically different would be absurd were it not for the want of a better method. Table 1 presents examples of such typical effort to make use of cost data comparing monthly cost reports of seven central stations. Their equipments are widely different; no two of them use the same grade of coal; the arrangement of machinery requires in some cases double the number of attendants; one is generating electric current for a trunk railroad, whereas others supply suburban and tunnel traffic or even private consumers, with consequent differences in characteristic of current, distribution of load and peaks during the day, etc. Under such circumstances, to say from those data that one is operating more efficiently than another is at least too presumptuous.

The most interesting attempt to devise means for more rational cost studies was offered by Messrs. H. G. Stott and W. S. Gorsuch (Transactions A. I. E. E. 1913, Vol. II, p. 1619). Yet the use of various factors tending to compensate for differences in fuel, load factor of load, labor cost, etc., are evidently inadequate. Prices per heat unit in shape of fuel, if adjusted, do not ascribe the differences in cost to either inherent efficiency of boilers, furnaces and stokers, or to the methods of firing and the personal element of attendance. The effect of load factor corrections is entirely offset by existing differences in the water rate of turbines and influences of auxiliary apparatus in the plants under comparison. Payroll correction factors established on the basis of mere payrates is erroneous, because of the size of units, floor plans, automatization of certain operations, etc., not mentioning the fact that generally low pay to attendants results in high cost per kilowatt-hour, usually on the coal item and often in maintenance. Even if these factors of correction were unquestionably correct, this method leaves the effect of supremacy of equipment efficiency unseparated from efficiency of methods of management. Finally, even if all factors are fully accounted for, the fact that one plant is equally economical to another does not tell how far each of them is from its possible degree of perfection.

The idea was voiced at the Spring Meeting of the Society in Buffalo, in June, 1915, by David Rushmore, that the oppor-

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tunity existed for standardizing cost accounting for industrial plants, and hoped that some member would lay before the Society a method and data for establishing such a standard. Proper tabulation and distribution of costs is, however, of lesser importance than a satisfactory method of analyzing the data collected. It is the writer's belief that the time is now ripe to consider these questions, at least in this one branch of manufacture, namely, generation of power.

decreasing with the increase of output. They are exemplified by interest on investment, depreciation, sinking fund, insurances, management, pay roll (in some cases), taxes, etc.

Expenses that vary with the output of the plant characterize, other conditions being constant, the efficiency of operation, and their elements stand together in dependent sequence. If represented graphically, they show very irregular shaped curves peculiar to each set of equipment. Unit cost has a

TABLE 1 COMPARATIVE COST OF OPERATION AND MAINTENANCE OF POWER PLANTS—JUNE 1915

			A		B		C		D		E		F		G	
			Dollars, Total	Cents per kw-hr.	Dollars, Total	Cents per kw-hr.	Dollars, Total	Cents per kw-hr.	Dollars, Total	Cents per kw-hr.	Dollars, Total	Cents per kw-hr.	Dollars, Total	Cents per kw-hr.	Dollars, Total	Cents per kw-hr.
Operation	Labor	Boiler Room	2233.21	.036	1639.45	.056	2686.34	.025	4967.27	.0195	3076.18	.0318	3283.50	.0855	1133.95	.052
		Turbine Room	1116.52	.018	679.89	.024	1682.89	.016	3156.36	.0124	1471.10	.0153	1472.54	.0383	756.10	.035
		Electrical	1080.52	.018	522.75	.018	536.12	.005	982.22	.0039	1105.73	.0114	264.28	.0120	144.87	.007
		Superv.—Janitors and Watchmen	563.14	.009	531.99	.018	601.26	.006	1230.89	.0049	460.85	.0048	1061.43	.0276	149.80	.007
		Total Operating Labor	4993.39	.081	3374.08	.116	5506.61	.052	10336.74	.0407	6113.86	.0633	6281.75	.1634	2184.72	.101
	Material	Coal	20535.00	.335	7338.55	.252	29945.89	.285	73803.55	.2908	35260.67	.3648	11820.31	.3075	8587.80	.395
		Water	675.65	.011	59.56	.002	1618.32	.015	475.42	.0019	1353.96	.0141	789.18	.0205	30.69	.002
		Lubricants	84.02	.002	61.11	.002	44.88	.001	226.47	.0009	270.81	.0028	135.68	.0035	68.13	.003
		Miscellaneous Material	194.55	.003	157.30	.005	27.70	.000	2043.91	.0080	35.12	.0004	555.73	.0145	149.87	.007
		Miscellaneous Charges	20.91	.000	Cr. 1.55	.000	757.96	.007	...	...	...	...	...	...	129.87	.006
		Total Operating Material	21510.13	.351	7614.97	.261	32394.75	.308	76549.35	.3016	36920.56	.3821	13300.90	.3460	8966.36	.413
		Total Operation	26503.52	.432	10989.05	.377	37901.36	.360	86886.09	.3423	43034.42	.4454	19582.65	.5094	11150.86	.514
Maintenance	Labor	Building	40.95	.001	129.36	.004	190.19	.002	1312.28	.0052	140.91	.0015	77.35	.0020	2.35	.000
		Boilers	291.36	.005	319.27	.011	703.13	.007	641.67	.0025	751.72	.0078	279.49	.0073	139.45	.006
		Boiler Room Auxiliary Apparatus	173.89	.003	268.33	.009	594.54	.005	520.47	.0020	280.40	.0029	66.15	.0017	31.49	.002
		Turbines	1055.16	.017	27.49	.001	328.36	.003	55.50	.0002	361.42	.0037	286.24	.0075	1.84	.000
		Auxiliary Apparatus	142.08	.002	21.23	.001	561.59	.005	322.21	.0013	176.86	.0018	334.92	.0087	6.83	.000
		Electrical Apparatus	9.32	.000	1.50	.000	399.57	.004	119.43	.0005	353.12	.0037	85.69	.0022	1.23	.000
		Piping	85.83	.001	54.03	.002	389.61	.004	433.24	.0017	119.59	.0012	131.69	.0034	136.05	.006
		Miscellaneous	49.40	.001	55.06	.002	132.23	.001	55.69	.0002	396.04	.0041	1.92	.0001	23.78	.002
		Total Maintenance Labor	1847.99	.030	876.27	.030	3299.22	.031	3460.49	.0136	2580.06	.0267	1263.45	.0329	343.02	.016
	Material	Building	212.17	.004	99.98	.004	799.08	.008	3490.00	.0137	2.19	.0000	29.65	.0008	15.14	.001
		Boilers	295.16	.005	66.56	.003	895.22	.008	1389.30	.0055	702.81	.0072	169.67	.0044	457.45	.021
		Boiler Room Auxiliary Apparatus	50.22	.001	40.28	.001	836.39	.008	529.10	.0021	88.08	.0009	73.00	.0019	36.18	.002
		Turbines	78.42	.001	.25	.000	739.08	.007	27.48	.0001	18.35	.0002	78.08	.0020	5.54	.000
		Auxiliary Apparatus	41.08	.001	8.18	.000	1344.22	.013	68.04	.0002	143.86	.0015	1300.79	.0338	28.15	.001
		Electrical Apparatus	14.06	.000	.84	.000	138.89	.001	766.58	.0031	137.70	.0014	162.13	.0042	...	...
		Piping	20.69	.000	7.94	.000	220.35	.002	574.31	.0023	81.34	.0008	200.10	.0052	149.53	.007
		Miscellaneous	8.76	.000	2.13	.000	127.11	.001	82.47	.0003	209.01	.0022	...	...	60.60	.003
		Total Maintenance Material	720.56	.012	226.16	.008	5100.34	.048	6927.28	.0273	1383.34	.0143	2013.42	.0523	752.59	.035
		Total Maintenance	2568.55	.042	1102.43	.038	8399.56	.079	10387.77	.0409	3963.40	.0410	3276.87	.0852	1095.61	.051
Summary		Total Labor	6841.38	.111	4250.35	.146	8805.83	.084	13797.23	.0543	8693.92	.0900	7545.20	.1963	2527.74	.117
		Total Material	22230.69	.363	7841.13	.269	37495.09	.356	83476.63	.3289	38303.90	.3964	15314.32	.3983	9718.95	.445
		Total Lab. and Mat'l Pow. Sta. Proper	29072.07	.474	12091.48	.415	46300.92	.440	97273.86	.3832	46997.82	.4864	22859.52	.5946	12246.69	.562
		Other Items Chg. to Pow. Sta. Accts	676.55	.011	676.55	.023	294.42	.003	2024.28	.0080	...	...	966.73	.0252	255.52	.013
		Total	29748.62	.485	12768.03	.438	46595.34	.443	99298.14	.3912	46997.82	.4864	23826.25	.6198	12502.21	.575
		Net Output in kw-hr	6133065	...	2915417	...	10509685	...	25286650	...	9664081	...	3844419	...	2171400	...
		Total Power Generated, kw-hr	6211195	...	2941018	...	10625545	...	25385400	...	9781610	...	4043803	...	2171400	...
		Lb. Coal per kw-hr	2.68	...	2.72	...	2.18	...	2.062	...	2.682	...	3.78015	...	3.40	...
		Cost of Coal per 2000 lb., Dollars	2.50	...	1.85	...	2.613	...	2.803	...	2.72	...	1.61	...	2.33	...
		Load Factor—Machine, Per Cent	59.6	...	74.5	...	64.56	...	73.17	...	86.6	...	49.0	...	64.0	...
		Load Factor—15 Min. Max., Per Cent	45.3	...	23.8	...	36.37	...	90.44	...	58.1	...	35.0	...	112.0	...
		B.t.u. per net kw-hr. Output	38289	...	33513	...	30716	...	29561	...	38046	...	43627	...	49300	...

CLASSIFICATION OF EXPENSES

All expenses incurred in the course of power production fall under analysis into two main groups:

a Constant (within a certain range) for any output

b Variable in some direct proportion with the output

Expenses that are independent of volume of output are at the same time independent of each other and do not characterize the efficiency of processes performed in the power plant. Their effect on unit cost is represented by a parabolic curve

general tendency to drop with increased output, as the efficiency of boilers, turbines, etc., tends to improve with increased load; yet as with higher degrees of overload the efficiency decreases, the unit cost rises. With further increase of load when an additional unit is started, the efficiency again begins to improve until their cumulative efficient capacity is exceeded, when the unit cost commences to increase again. Such waves are sometimes very pronounced and generally, throughout the range of the plant's capacity, the number of waves on the unit cost curve is equal to the

number of generating units installed. Fuel, water, certain supplies, and in less pronounced dependence, maintenance expenses, belong to this group of expenses, and for the purpose of classification of expense account, it is best to itemize them correspondingly to the steps in which the energy is transformed during the generating process.

The criterion of economy is formulated by the interplay of three factors, *time, product* and *cost.* When only one factor varies, its effect on economy can easily be foreseen. Thus greater product, without change of time required or cost, increases the economy. Increase of either time of production or cost of production reduces the economy. Generally, however, all the factors vary simultaneously, in which case the analysis of the equation of economy criterion $e = \frac{P}{ct}$ can be made for any influential element *n,* and the increase of economy of unit increase of *n,* if differentiated, is

$$\frac{P}{ct} = \left(\frac{P'n}{P} + \frac{C'n}{C} + \frac{t'n}{t}\right)$$

all elements essentially positive.

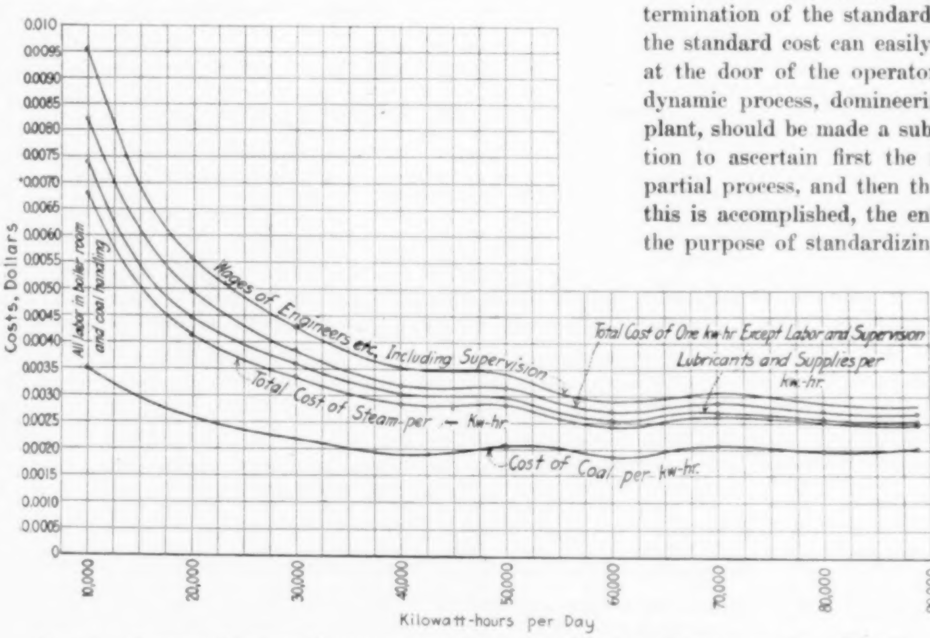

Fig. 1. Curves Showing Variation in Standard Costs of Operation in a Public Utility Central Station

Such a general study can be made with respect to economy if more than one influential element is involved as simultaneous equations for each. The graphic method offers, however, an easier means of solving the problem. To determine the *economic limit* reached by continuous increase or decrease of influential elements is by no means an easy problem, but unless it is solved we are in the dark not only as to *what economy can be obtained,* but also *what changes in conditions and methods are essential.* The analysis of the effect of the variations of these elements involved in determination of *maximum limit of economy* can be compared to a determination of the height of the apex of a hill by taking altitude readings on both slopes in one direction and then repeating observations in the crosswise direction.

STANDARD COSTS

It is relatively unimportant whether the maximum limit of economy is determined empirically by rigorous observations, tests and analyses of all influential elements, or calculated from the principal data already available. ***It is imperative that such study be made and the economy limit established, as this is the only criterion for judging the actual performance.*** Carrying out the analysis of economy limit to its logical conclusion, the standard cost of product is arrived at, and evidently during this investigation, not only are itemized costs of individual partial processes found out, but the conditions and methods whereby standard cost can be attained are established. In other words, ***unless the standard costs are established there is no measure of existing losses or exact knowledge how to eliminate them.***

Manifestly, in the course of determination of standard operating cost, such factors as inherent efficiency of equipment, its efficiency under different loads, prices of fuel and supplies, necessary and sufficient number of attendants and their compensation, etc., are already taken into consideration for a given plant. Any deviation observed between the actual operating cost and this standard cost indicates that some of the necessary conditions were not lived up to and, if standardization has been carried out in sufficient detail, it leads directly to the allocation of the loss to operating methods. On the other hand, any change in the basic data used in determination of the standard cost being known, adjustment of the standard cost can easily be made before the blame is put at the door of the operators. The efficiency of the thermodynamic process, domineering the operating cost in a power plant, should be made a subject of a most thorough investigation to ascertain first the maximum efficiency limit of each partial process, and then the result of their interplay. When this is accomplished, the entire process will be re-studied for the purpose of standardizing methods and adjusting for such a balance of efficiencies of partial processes as will secure the maximum profit or economy from the expenditure of time, energy and money involved. In this, it is sometimes found that the most economical thermal efficiency is somewhat below the maximum obtainable, as the slight additional gain in efficiency necessary to reach the maximum is not warranted by the expenditure required for its attainment. When these limiting conditions are studied and determined, a method can then be defined for each member of the working force, prescribing his duties and the conditions he must maintain to secure the *most profitable* degree of efficiency.

Upon the conclusion of these studies, the best efficiency of each unit and their combination being known for any load, the standard cost for any output in a given time unit can be conveniently represented in graphical form.

The principles of determining the standard cost of maintenance and upkeep of the plant and equipment are substantially the same; the method of study, however, is somewhat different. It involves a study of design and construction of all elements of equipment; minute records of their service and cost of maintenance may lead to a modification of design, use of cheaper renewable parts, etc. Next, the standardization of supplies, beginning in the laboratory and followed by actual service tests, helps to determine not alone the purchase price, but the lowest service cost. Finally, time studies embracing schedules for inspection, routes for maintenance

men, standardization of tools, motions, methods, etc., conclude the investigation. The criterion is, of course, not the wages of the employee, but freedom from accidents, breakdowns and the lowest attainable cost of upkeep per unit of the plant's output. It is evident that there may not be any theoretically certain standard cost of maintenance, but an empirical standard thus developed is generally but a fraction of the best actual records of the past.

CURVES OF STANDARD COSTS

Upon conclusion of this double analysis of the maximum economy obtainable, the graphs of standard cost of power production may be drawn. Curves may be conveniently arranged in the co-ordinates of cost C and product per unit of time $\frac{P}{t}$ (output). It will then be noted that the time element is one of the most influential factors in power economy. Whereas in some cases, where the number of generating units is large, the coal-rate per unit of output remains fairly flat and the other items of cost reduce rapidly with increased production per unit of time, in other cases the standard cost of fuel also decreases as the time during which a certain output is produced is reduced. Figs. 1 and 2 represent curves of standard operating costs. It is evident that any number of curves may be plotted following the above method, each curve representing an itemized standard cost according to the adopted classification. Fig. 1 is thus prepared for a medium size public utility central station. It shows the variations of standard costs of coal, boiler room labor, water, supplies, overhead charges, engineers and supervision per kilowatt-hour at various monthly outputs. The cost scale does not show, however, the actual standard. This plant comprises four 600 h.p. boilers and three turbo generators, one of 2,500 kva. and two 500 kva. rating; it operates 24 hr. per day, 7 days a week.

From this diagram it appears that the cost of coal per kilowatt-hour is lowest when the output of the plant is approximately 1,900,000 kw-hr. per month. Further increase of output coincides with the increased cost for fuel required, due to the characteristic of boilers and turbines that they lose in their efficiency at higher rates of driving. Again, costs of labor, supplies, pro-rate overhead charges, etc., per kilowatt-hour, which drop more rapidly than the cost of fuel rises, offset the difference and render a greater monthly output more desirable economically. Even there, however, we meet a limit when at the rate of 2,200,000 kw-hr. per month the unit cost becomes higher than it was at the lower output of 1,900,000 kw-hr. per month.

Fig. 2 illustrates a few characteristic curves of standard cost per kilowatt-hour for various rates of output of a large central station feeding the lines of an electrified trunk railroad. The plurality of waves on the fuel cost curve, etc., is explained elsewhere in this paper and the tendency of total standard cost to go steadily downward with increase of the output rate is due to the plurality of generating units.

USE OF STANDARD COST CURVES

Practical use of such predetermined standard costs can be made extremely simple by the use of these graphs. For busy executives or owners, the entire cost record visualized by graphical representations of the items of account is found very convenient. An example of such a graph is seen in Fig. 3, wherein the actual unit cost and the standard unit cost are plotted to the same scale, the deviation of one from the other suggesting at a glance the degree of perfection of the performance. The total expense curve and the cumulative expense curve may be shown on the same graph to a suitable scale; the latter curve is found very serviceable for comparing these items with the appropriation made. A cost system kept on a card file in this manner will represent clearly in any desired detail for any length of time and at any period:

a How much was spent
b How much each unit of output cost
c How much it should have cost
d What the fluctuations of expenses and unit cost are
e What the fluctuations of efficiency are
f How close the actual amount spent in any time is to the appropriation.

The accuracy of such graphic records is sufficient for most practical uses and references, as it allows the interpolation of unit costs to 0.001 of a cent. If the exact total of expenditure is wanted it can be had at any time from the book records, whereas the use of books and figures exclusively lacks the comprehensiveness and visual instructive value of graphs.

Any comparison of production costs of various plants may now be made in a different light. By comparing standard costs of one plant with those of another, one gains the knowledge of how much cheaper the power can be produced in one plant than in another, due to its various physical advantages, corrections for load and output all being automatic. Again, by comparing how near the actual cost of one plant is to its standard cost with the difference between actual and standard cost of another plant, one has at once a measure of quality of methods and management. Thus, referring to our Figs. 1 and 2, the actual cost per kilowatt-hour of 35 cents in one plant means a worse operating efficiency than 48 cents in another plant under another load condition. Yet without such accurately predetermined standard costs that are individual for each plant and condition of load, no correct comparison is possible, and conclusions from a mere study of accountants' figures are apt to be grossly in error.

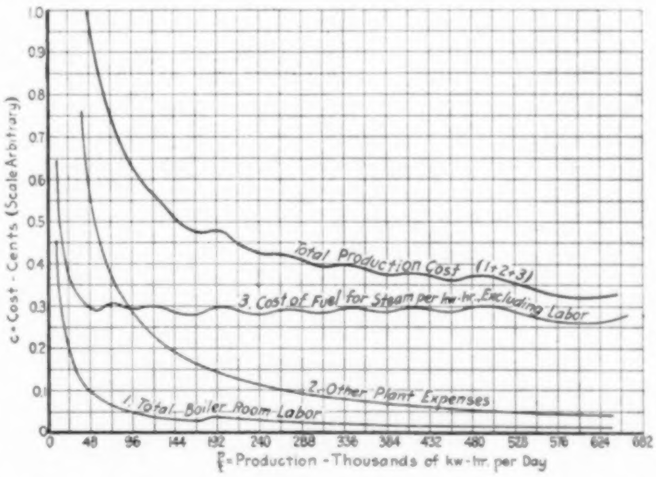

FIG. 2. CURVES SHOWING VARIATION OF STANDARD COSTS OF POWER PRODUCTION AT AN ELECTRIFIED RAILWAY CENTRAL PLANT

STANDARDIZATION OF OVERHEAD CHARGES

In the above discussion of standard cost we left out of consideration, however, a very important feature—namely, fixed charges borne by the plant. It is a very common policy to install in power plants considerable spare equipment, partly as a protection against possible breakdown and partly to take care of high peak loads. In both cases, it would not be logical

to adulterate production costs by the addition of all overhead charges incident to this idle equipment. If all charges due to policy, over-equipment, protection, spare units, new business anticipation and similar allied items are accounted where they belong—not against the operation—the cost of producing the current will appear constant unless prices of fuel, supplies, wages, etc., are changed or methods of management are not uniform.

Inasmuch as the spare equipment has a function identical to a stand-by plant at some distant point of transmission line or a breakdown emergency connection with a power company nearby, it seems entirely proper to segregate this portion of charges and treat them in the same manner as the bills of an emergency contract, *i.e.,* to carry the cost on a separate business account. The parallel between a breakdown connection contract and a plant's own breakdown reserve is apparent, yet it is only too often that the same concern, charging the bills on such a contract against the general business or protection account, insists that the power department shall absorb in its operating account all expenses accrued in the reserve plant or any part thereof.

The degree of safety and protection from interruptions with which it may be desired to maintain the service is dictated by the general policy of the concern; similarly, the decision to keep a stand-by station in readiness to go into service at a moment's notice or the policy of keeping within the central station a certain number of boilers banked, turbines warmed up and generators phased, should not obscure the cost and efficiency data pertaining to the generation of power. The expenses incurred in connection with such a *protective service* should not be charged to the operating or production account, but might be arbitrarily standardized, reduced or increased as the business policy might require and be *treated as an independent account.*

If, in the case of a plant built and equipped to produce twice the output it normally carries, fixed charges are dumped together with operation costs, it reflects unfairly on the ability of the superintendent and his operating force; whereas if they were properly charged to a separate account, the excessive charge against the stand-by equipment, both for fixed charges and running expense, would produce a stimulus for the new business, or commercial, or transportation departments to secure additional load. It is a quite common condition that these departments are not fully aware of the reserve capacity of the plant or plants or, on the contrary, secure more load than it is safe to carry permanently or until an additional generating equipment is provided. *Standard* cost of protective policy would act in all such cases as a gage on a tank of certain capacity with outlet and inlet valves subject to continuous adjustments. In other words, *the new business departments should at all times know the ratio between ideal protective costs* and actual cost of carrying the unutilized portion of power generating equipment.

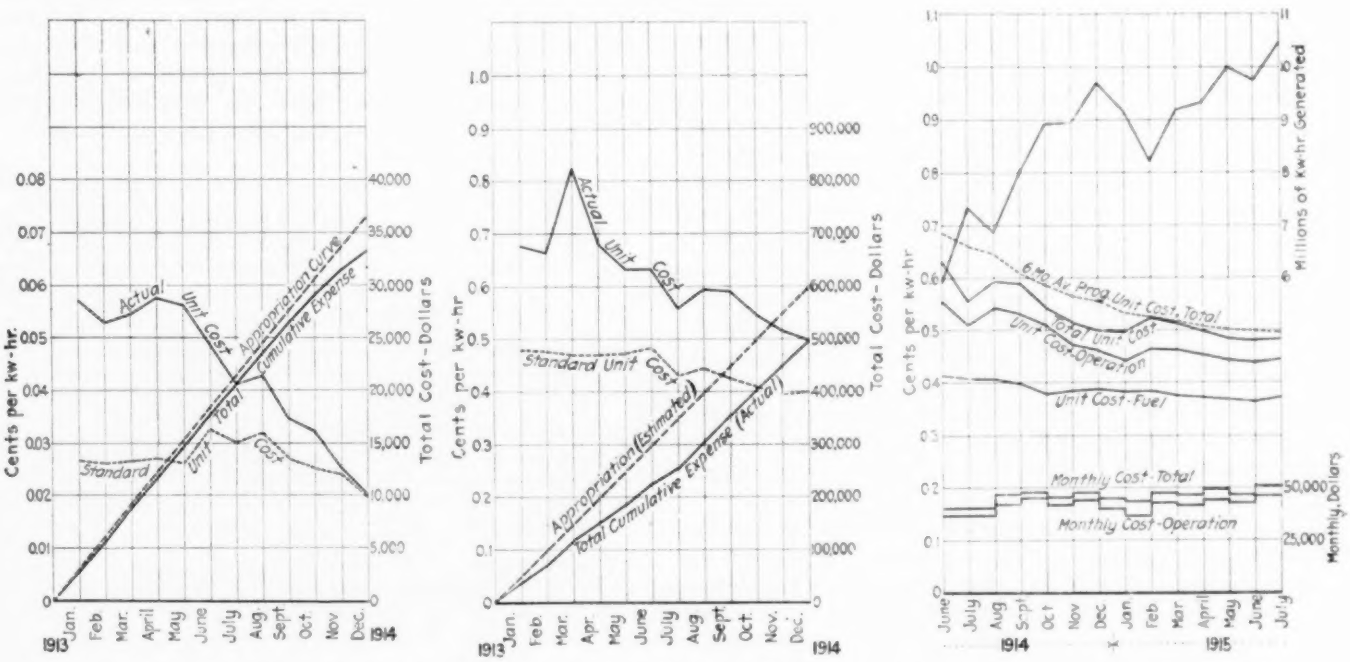

FIG. 3. VISUALIZED RECORDS OF THE ENTIRE COST OF POWER PLANT OPERATION, IN WHICH THE ACTUAL UNIT COST AND THE STANDARD UNIT COST ARE PLOTTED TO SAME SCALE

COMPARISON OF COSTS AND EFFICIENCIES

The cost system developed along the lines discussed will not only afford a means for clear understanding of operating and managerial problems, but offer a basis for cost comparison of different plants. The essentials of knowledge gained through a comparison of actual cost in conjunction with the standard are:

a Relative supremacy of plants proper
b Relative advantages of managerial methods
c Relative extent of preventable losses
d Relative advantages of prices of materials, etc.

These cannot be found unless there is a comparable basis or scale for comparison, which is offered by standard costs determined for each plant individually, as at least ten main variables must be accounted for, as follows:

a Nature of load
b Character of service
c Conditions imposed by location
d Inherent efficiency of equipment
e Arrangement of equipment, floor plan, etc.
f Cost-efficiency of fuel and supplies

g Legal requirements
h Methods of operation
i Labor conditions
j Methods of compensation for service

Each of these variables being in its turn a product of a plurality of factors, it is manifestly impossible to state, without the aid of carefully worked out standard costs, that the economy of one plant or another is satisfactory, or where and how it can be bettered.

Inasmuch as standard cost cannot be determined without first finding out how the maximum economy can be secured, the process of standardization of costs is also a process of devising the best way for operation and management. Once both methods and results are positively established, costs are but the form of expression of the final result. It is true that the standard cost is influenced by the price of commodities used in the course of generation of power, as well as by some conditions beyond the control of the management and operating engineers, but the adjustment of the standard costs to every change of these factors can be made as simple as the use of a slide rule. Furthermore, a separate account should be kept for such charges as are the part of business policy, so that a division of responsibility between those managing the production and directing the business could be drawn.

As long as costs of production of power come as an unexpected surprise and arouse the curiosity to an extent of comparing them with the preceding month, year, or any other plant's data—the management of such power plants is evidently a very haphazard undertaking, lacking the aim at any definite goal. Without pre-determined standards, superintendents and managers will continue to believe that they control the production and owners will remain in a happy ignorance as to how much of their money goes to waste and why. Only after the establishment of standards and ideal costs of production by means of the most rigorous analysis, will cost accounting be of help to engineers, and only then can it be said that the generation of power is directed by management and controlled by engineers.

DISCUSSION

R. J. S. Pigott (written). Mr. Polakov's instructive paper deals with graphic methods such as the writer is at present using in analyzing costs in the plant with which he is connected. Mr. Scofield of the Minneapolis Street Railway Company is also making use of similar methods, and has been for some years. In the Power Generation Committee report for the American Electric Railway Association for 1915, Mr. Scofield and the writer gave an analysis of steam power station cost along similar lines to the paper of Messrs. Stott and Gorsuch, in which Mr. Scofield gave in full the method of analysis of steam power station cost graphically.

There is another supplementary use of this method of analysis which is also very important, viz: laying out and selecting the apparatus in the design of a power station. The writer did a good deal of development work on this method while teaching at Columbia University in 1911 and 1912; earlier work was done by Horace W. Flashmann and C. E. Lucke. The method in general involves the use of the so-called Willans line, for both individual apparatus and for the station as a whole. The value of this method depends chiefly upon a thorough knowledge of the heat distribution in the plant.

William D. Ennis presented a written discussion in which he stated it is perfectly true that accountants' records in themselves are inadequate and that such records must be supplemented by more detailed information for engineering analysis; yet it must not be forgotten that the former records are the official and final figures, and that owners are interested only in the final result. They will not take kindly to the elimination of overhead charges on idle equipment from the operating account. It all goes in the jackpot. Furthermore, relative necessities for reserve equipment and breakdown service strongly influence the decision as to what is the best type of equipment for a given set of conditions. Certainly breakdown service is not provided for the sake of anticipated "new business."

While Mr. Polakov, who speaks from the operating rather than the design standpoint, regards the proper tabulation and distribution of costs as less important than their analysis, there is something to be said on the other side. Proper tabulation is the essential prerequisite for any sort of analysis, and in this respect our power plant management is defective or at least un-standardized. Table 1 gives operating and maintenance costs. It would be a matter of some complication for any power operator to line up these figures with his own. Different power companies classify their costs in different ways. There is not even a clear distinction drawn between the items "operation" and "maintenance." It would be a decidedly useful thing if we had a standard classification in power station accounting, such a standard classification as those used by all industrial corporations. The preparation of such a classification would be very properly the joint work of a number of national and commercial engineering societies, together with perhaps the representatives of public service commissions. It is too big a job for one man or even one committee. It should have been done long ago. Mr. Polakov's paper (perhaps unintentionally on the part of its author) emphasizes its necessity. The classification should be flexible enough to include any type of power-generating industry and specific enough to show at a glance the standard account chargeable for every possible item of expense. It should be accompanied by a standard list of subordinate data desirable, such as heat value of coal, load factor, service log, etc. Central stations would no more than at present be expected to publish their costs, but when costs were furnished, the reader would know without explanation the meaning of each item.

Geo. L. Fowler said that there is probably not one owner of a power plant in a hundred who has the slightest idea of what it costs him, and if Mr. Polakov can go out and persuade all the power plant owners in this country to find out what it costs them to run their engines and boilers, the saving he would be the means of effecting would be tremendous.

He related some personal experiences of what it costs to run a power plant under the condition of absolute apathy of the owners as to the conditions in the engine room. In one case he had found that the cost per horsepower per year in a number of plants in one town ranged from $28 to $150, and he thought this was typical of the condition of affairs all through the country.

He cited the case of an engine in which a slight shift of the eccentric varied the cut-off sufficiently to cause the efficiency to drop down 22 per cent, and he said that all over the country we have hundreds of engines in just that condition.

He admired the author's ambition in presenting this paper and endeavoring to get the engine owners of this country to accept his theory and work along these lines, but he thought the task was almost impossible of accomplishment.

HENRY G. STOTT. I think that by the word "standardization" in the title of this paper the author means "segregation," for he seems to advocate treating each plant by itself and establishing a standard for each plant. "Standardization" is to bring into one category a number of plants, each of which is different.

Real standardization can only be accomplished on two principal bases: *first,* the thermodynamic efficiency of the cycle used in the plant as compared to the ideal, and *second,* the measure of efficiency of management of the apparatus which has been put at the disposal of the man who is running the plant, and that is the cost of power.

There is no more complex subject than the cost of power, as there are so many elements entering into it. The paper touches upon only a few of these elements. Contrary to the author's statement, predetermination of results of power production is purely an engineering question, so far as the power operation is concerned. I have never heard of an accountant being asked to furnish an estimate of how much it costs to furnish power.

The items in Fig. 1 are interesting, but no basis is given as to how they are derived.

The author states the expense incurred in connection with keeping a standby unit should not be charged to the operation or production account, but should be treated as an independent account. That, of course, is absolutely impossible, because it is just as much a part of the cost of producing power to carry the reserve power as it is to carry the main unit in operation, and it is just as proper to charge a reserve unit into the cost of power as the operating unit.

W. F. SCHALLER. It seems that in attempting to establish a standard for any particular power plant, the coal and supplies used, the labor, to a certain extent, and also the method of keeping accounts, should be standardized. This leads to a series of accounts for power plants which can probably best be obtained from a central office.

A central power plant office of this kind can be maintained at rather low cost. For instance, one power plant in the vicinity of New York maintains such an office at an expense of about 0.4 of 1 per cent of the total payroll.

As to the proposition of figuring standby costs and charging them to separate accounts, if a plant has such a load that a number of extra boilers have to be kept on the line, and the plant is to be compared with another which has a steadier load, so that the smaller number of boilers need be kept hot in reserve, it is unfair to compare directly the coal per kilowatt.

WILLIAM KENT. Some time ago we endeavored to learn what was the standard of performance for the woolen mills in the valley between Worcester and Pawtucket. We investigated the cost of production in every mill between those two cities, and obtained the steam cost as well as we could from data of boiler and engine tests, house books, etc. The minimum cost in a plant of 50 h.p. ran at about $110 per horsepower year. In a 2000 h.p. plant it was about $18. Plants which figured out higher than the minimum for their particular size were obviously variations from the standard.

The standard in this case was a first-class compound condensing engine with good vacuum and good boilers. Today we would say that this standard should be lowered. For instance $1 or $2 should be taken off on account of the use of first-class mechanical stokers.

For any plant, it is necessary to have the standard for the conditions, not the thermodynamic standard, nor the Diesel engine standard, nor the Carnot standard, but the standard for the best accepted practice in that size plant.

JOHN W. LIEB. Mr. Polakov in his analysis has indicated, in addition to the analysis from the viewpoint of the operating engineer, certain factors, such as politics, business management, and fixed charges, which are not properly qualified operating costs, but elements of central station economics having to do with finance and management. From this point of view, the author has not been very happy in his standardization of terms. He starts out with a statement of production costs. Now production costs in central station economics have come to mean a definite thing. They are the items of operating cost comprised, for instance, within the standard classification accounts used by the company members of the N. E. L. A. They do not include any fixed charges, or general expense, but definite items of expense incurred within the walls of a power plant. They exclude all elements of interest, insurance, taxes, general expense, return on capital and depreciation of various kinds. They include merely the items that go into what is known as switchboard cost, which is a very specific and definite thing in the central station industry, and production costs are quite different from the cost of power.

In this question of production costs, some work has still to be done in the branch of standardization from year to year,—generally accepted standardization as to comparisons between which shall serve as the unit measurement of the production costs; whether that shall be the gross output of the generators, or the gross output less auxiliaries, or the gross output less excitation, or the gross output less lighting and power uses within the power plant, or the net output as delivered to the outgoing high tension feeders. Then, again, as to considering the load factors as the basis of comparison between one station and another, there is not a general agreement as to the time interval over which the so-called maximum demand on the plants shall be made, so that there is still adequate room for the standardization of production costs.

J. C. PERCY. I believe that the system of standardized statistics, such as the United States Steel Corporation uses on their blast furnaces, is the greatest factor for improved operation. This guides the executive committee and aids each manager. By these statistics equipment, quality of material, chemical actions and skill in management are all compared. This leads to an improvement in operation which has no fixed limit for a standard.

Many of our large public service corporations, recognizing the value of this, have an elaborate system for the interchange of statistics and data.

The smaller power plants of the factories which interest many of us have not been touched upon; a greater good could come to these plants by establishing such a standard of interchange of statistics, giving a deadly parallel for comparison, than by a separate predetermined standard as given in Mr. Polakov's paper for each small plant.

J. A. KINKEAD. It is evident that the central station plant and the isolated plant are separate propositions. There is no question at all that the large central plant can throw out obsolete equipment, and can employ the very best engineers to operate their plants, because their units are so immense that a very slight saving in percentage means a big saving at the end of the year. On the other hand, the smaller power plants cannot conveniently discard their obsolete machines and put in

new equipment, but it is of very great importance to the users of small plants to know whether their plants are being operated under the most economical conditions or not.

As I understand this paper, its idea is to give some basis on which to compare various power plants operating in this country,—not necessarily the central station power plants, because we know most of them are operated under the maximum conditions of efficiency.

SELBY HAAR. If a certain ideal condition is established, as suggested by Mr. Polakov, or one of a similar character, how long will it remain standard? Every hour even some improvement is brought forward, and the bottom is knocked out of all of our preconceived and carefully standardized ideas.

THE AUTHOR. It is to be regretted that in the entire discussion drawn by this paper, both subject and method presented were not touched upon. It is true that an average owner of a power plant, as Mr. Fowler says, does not know much about the basic principles involved, but it is not true that accountants are never asked to furnish power cost data.

Mr. Lieb overlooks the division line drawn in the paper between production cost and overhead charges, and it is just the thing that the paper exposes as a harmful fallacy that Messrs. Percy and Ennis approve of. Again, Mr. Haar's criticism is applicable only to a hypothetical plant in which "every hour" a new improved equipment is installed, but the author's central and only idea in this monograph was silently accepted.

The cost of power is the result of method as well as of other factors. Price of commodity and labor used is known; efficiency of equipment used is known; nature of service is known, and their influence on cost of product is easily found from a comparatively simple study. In a given plant these factors remain constant until change is made by purchase. For different plants factors of merit could be established equalizing for the unequal condition. Now if costs vary it is due to variation of the methods of management of the plant. If these methods are standardized, and the costs still vary, other conditions being constant, it means that standard methods are not lived up to; that is, the management fails to manage.

The paper thus offers a method of measuring the efficiency of the plant management. If the principles and methods are right, the results will necessarily be the best obtainable and consequently the only best method or "standard method" finds its expression in the lowest possible cost or "standard cost."

Comparing such standard and actual results, with due allowance for uncontrollable factors, we get the measure, established on a scientific basis. Under such regime the plant management ceases to be a humpty-dumpty undertaking and most preventable losses are eliminated. Separate and aside from the operating and production costs are other elements of overhead charges, and a separate plea is made to analyze them independently, so that their reason and purpose be clearly indicated, and if expense is made for no useful purpose or on poor reason the remedy could be found.

The new buildings of the Massachusetts Institute of Technology situated on the Charles River Basin, Cambridge, Mass., will be dedicated on June 12, 13 and 14, 1916. The engineering buildings will contain extensive hydraulic, steam and chemical laboratories, in addition to the electrical department. The group of science laboratories, situated apart from the engineering laboratories, will be most complete in facilities for precise research work in addition to undergraduate instruction.

SPECIAL STEELS

BY SAMUEL L. HOYT,[1] MINNEAPOLIS, MINN.

Non-Member

THIS paper has a more direct bearing on the special steels used in automobile service than elsewhere. However, I understand that the demands made on special steels by gas tractor practice are in most cases similar to those made by automobile service. At any rate, the advantages possessed by the special steels over the ordinary carbon steels apply with equal force to the two services. Materials for certain tractor parts would be selected with reference to abrasion resistance, especially at somewhat elevated temperatures, whereas in automobile service material for the same parts would be selected with particular reference to its dynamic toughness.

Nickel Steel. The first important special steel, of the type used in automobile practice, was nickel steel; in fact, the nickel steel first described by Riley in 1889 was an entirely new type of special steel, the special steels up to that time being those used for tool steel, etc.

The nickel is added for two reasons—first, on account of the strengthening effect, as 3½ per cent nickel increases the elastic limit of carbon steel by 50 per cent; and, second, the dynamic toughness, as shown by fatigue tests and the notched bar impact test, is double that of carbon steel. It must be pointed out, however, that this great improvement in properties can be secured only by use of a proper heat treatment.

Chromium Steel. Chromium steel was introduced by Mushet in the 60's in England and by Bauer in New York at about the same time. Its most noteworthy effect on carbon steel is the increase in hardness produced, but the elastic limit like that of nickel steel is also in excess of the elastic limit of carbon steel. Chromium also improves the physical structure of steels by making them finer grained. This has the effect of offsetting the lack of ductility of chromium steels which is evident from the relatively lower elongation and reduction of area. In this way chromium steel furnishes an example of the fallacy of judging steels by static tests alone, as the real toughness of construction steel is brought out only by tests such as the dynamic tests and notched bar impact tests.

Chrome-Nickel Steel. Here we come to the most renowned of all automobile steels. In considering the effect of adding chromium and nickel to carbon steel, let us consider first the nickel and then the chromium. Nickel on being added to carbon steel dissolves almost entirely in the ferrite and the effect is to increase the elastic limit. The second influence is that of decreasing the grain size which causes a marked increase in toughness which I have already referred to. Chromium, on the other hand, forms a double carbide with iron and the effect of adding chromium to nickel steel is to increase the hardness by means of the double carbide. In this way chromium raises the elastic limit and elastic ratio of nickel steel, but does not destroy its toughness.

Hence it is clear that chromium and nickel added together to carbon steel increase, very materially, the elastic limit, the elastic ratio, the dynamic toughness, and the hardness. This steel is an excellent example of the manner in which one special element can reinforce another special element when added to carbon steel and combine to produce a much superior steel. There are numerous steels on the market which have equal or

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even better static properties, but it is doubtful if they are equally capable of standing up in service chiefly on account of the difference in dynamic properties.

Chrome-Vanadium Steel and Chrome-Nickel-Vanadium Steel. Vanadium added to chromium steel and chrome-nickel steel produces an increase in toughness due to the fact that it makes them finer grained, more uniform, and more susceptible to heat treatment. The chrome-vanadium and chrome-nickel-vanadium steels are classed with the chrome-nickel steels as being the best construction steels as yet developed for this type of service.

Silico-Manganese Steels. Certain types of silico-manganese steels have been developed which possess exceptionally high elastic limits and which can resist vibratory stresses and therefore are useful as springs.

Tungsten Steels. Tungsten steels were used originally as tool steel on account of their great hardness, but they also possess a property which makes them of use in automobile service; viz., that of resistance to abrasion at elevated temperatures. On this account they are used for valves.

The advantage of the special steels over the carbon steels for use as construction steel is due, more than to anything else, to the increase in toughness which is secured, especially dynamic toughness. The carbon steels can be made appreciably stronger by increasing the carbon content and by heat treatment, but they would be made brittle and therefore of no use. The special steels, however, can be made strong and tough at the same time.

The increased toughness can be utilized in three different ways, according to Le Chatelier:

1. Maintaining the same strength and toughness, the parts can be made appreciably lighter. This is of great importance in automobile construction where weight is of prime importance, especially as far as speed, endurance, economy, and upkeep are concerned. The diminished weight is also an important factor in the cost of production as the extra cost of the special steels is oftentimes more than balanced by the lower manufacturing costs due to the lower weight. In gas tractor service a saving in the weight of the parts, especially the moving parts, lessens the sudden strains which are imposed by forced stopping and other irregularities in the service. But the advantages of using light weight parts, in place of heavy parts comprise not only the saving in handling the material on the floor, in machining and in assembling, but also the advantages derived by the buyer.

2. With the same weight and toughness the parts can be more heavily loaded. This lessens the danger of over-loading which often results in deformations sufficient to put the overloaded part out of service.

3. With the same weight and strength much greater toughness can be secured which amounts to insurance against accidents and failures.

In what is presented above, I have referred not to static toughness as determined by static tensile tests, but to dynamic toughness as determined in dynamic and impact tests. In fact a great mistake is made by judging the value of special steels by means of static tests alone, not only that the relative values of special and carbon steels are not brought out, but that at times the results of static tests are directly misleading. This is not a pleasant thought for him who would go to but little trouble and expense in testing construction steels, but it is a fact and as such must be squarely met.

I wish to repeat another important point in connection with the production and use of special steels; viz., in order to make special steels worth while, to justify the increased cost, they must be properly heat treated. This is a subject which has not as yet, at least in our country, received the attention which it deserves and which in the future is bound to be paid to it. This neglect is due, I believe, not only to the fact that the special steel industry is in its infancy, but also to the special difficulties of a scientific nature involved, both in the determination of the proper heat treatment to be employed for each particular case and in properly carrying out the heat treatment of the parts concerned.

Also I might add that the solution of the problem lies in two directions. The users of special steels, such as gas tractor and automobile manufacturers, must be awake to the possibilities of such use. In other words, the manufacturer must create a demand for a superior product in order that he may produce a more salable, a more durable, and a more economical machine. But it is also necessary for the maker of special steels, not only to produce high grade steels of the proper chemical analysis, but he must also know the kind of steel to be used and, what is more important, the proper heat treatment to suit the individual requirements.

Whether the maker of the steel, the manufacturer or a middle-man shall actually perform the heat treating, depends on which one is best equipped to do that kind of work. Of prime importance is that the heat treatment be properly done. In other words, the steel maker should advise with the manufacturer and tell him which steel is best suited for his particular purposes, all things considered, and what heat treatment is necessary in order to bring out the desired properties.

From my own experience I cannot say that this ideal state of affairs exists in the United States. As a matter of fact, the steel makers, as represented by their salesmen, while ready at all times to recount the virtues of their special steels, seem to possess little serviceable information for the purchaser and transactions are carried on largely on a basis of the static properties. One cannot wonder that many manufacturers feel that special steels are but an expensive luxury.

Next the kinds of steel used for different parts will be taken up briefly and, incidentally, I shall have a few words to say about case hardening practice.

Axles. It falls to the lot of axles to receive some of the severest strains which are encountered. Axles must be statically strong (high elastic limit), dynamically tough, and, if poor design or workmanship must be considered,[1] they should also have both high static and dynamic notch toughness. Toughness is secured by nickel and vanadium while strength is secured by nickel and chromium so that the steels to be recommended for axle service are nickel, chrome-nickel, chrome-vanadium, and chrome-nickel-vanadium steels.

Crank-Shafts. Many times it is desirable to reduce the weight of the crank-shaft and at the same time maintain a certain degree of toughness and stiffness. If so, it is advisable to use chrome-nickel or chrome-vanadium steel but of course the heat treatments would be different from those for axles. The requirements for this service are high resiliency in combination with comparatively low elongation so that heavy impacts can be absorbed without causing serious deformations in the crank-shaft.

Cam Shafts. The duty is naturally lighter on cam shafts than on crank-shafts and axles, but a saving in weight can

[1] It has come under my personal observation that both of these points require serious consideration.

be effected by using nickel, chrome-nickel, or chrome-vanadium steel.

Gears. Many heat treated gears are being used in place of case hardened gears. The combination desired is hardness and toughness, two properties which are difficult to combine in any one piece. However, a greater degree of toughness can be secured with the same hardness by using special steels. The chrome-nickel, chrome-vanadium, and chrome-silico-manganese steels are used for this purpose.

Springs. Springs require a combination of high elastic limit and high dynamic resiliency, and of course dynamic toughness. Springs and crank-shafts share the property of high dynamic resiliency in common. The difference for these two services is that in one case the permissible deformation is very small while in the other case it is necessarily large. The steels used for springs are chrome-vanadium and a special type known as silico-manganese.

Frames. Frames must be tough and have high resistance to vibratory stresses. Nickel, chrome-nickel, and chrome-vanadium steels are used extensively for this work.

Steering Arms. Steering arms are subject to a combination of stresses which is probably more complex than the strains on the other parts. For this reason the design and workmanship of steering arms are especially important. The steels used are nickel and chrome-nickel.

Roller Bearings. Roller bearings must be hard and yet not too brittle. There have been two types of steels developed for this work, viz., the high carbon-high chromium steel and chrome-vanadium steel oil-hardened.

Valves. If a special steel is desired for valves, it is usually tungsten steel, but certain high nickel steels are also used.

Case Hardening Practice. The first step in the process of case hardening, is annealing in the case hardening mixture or "cement" for a sufficient length of time and at a sufficiently high temperature to produce the case desired. The second step is called the first quenching which has as its object the regeneration or toughening of the core. The third step is the second quenching which has as its object the hardening of the case. There are many advantages secured by using the special steels and I shall mention several of them.

1. Certain of the special types are much less affected by the first annealing process than the carbon steels. That is, the annealing produces a much smaller growth in grain size which in itself, aside from the greater natural strength and toughness of the special steels, retains a greater tenacity and toughness in the core.
2. Certain special steels permit a modification of the heat treatment so that the first and second quenchings can be combined into one treatment which is so calculated that it is satisfactory for both the case and the core.
3. The results are rendered more certain by using special steels; i. e., the case can be made more uniform and harder while the core can be made stronger and tougher.
4. Deformations due to quenching can be more easily avoided with certain special types of steels, for instance, the air hardening steels. These steels belong to a class of steels that is not generally manufactured at present in the United States, and should not be confounded with tool steels.
5. A higher carbon content can be permitted in the core without losing the property of toughness. An example is furnished by the chrome-nickel steels with which a carbon content of 30 per cent can be used, a steel which also produces a hard case suitable for parts subject to wear and shock.
6. In carbon steels two of the constituents, ferrite and cementite, have a habit of forming in relatively large crystals, the presence of which is dangerous on account of the brittleness and liability of exfoliation produced thereby. This can be eliminated by using special steels.
7. The use of special steels greatly increases the efficacy of the treatment.

The parts which are commonly case hardened are cam shafts, roller bearings, and gears. For cam shafts a low carbon, nickel or chrome-nickel steel is used which is case hardened on the wearing surfaces of the cams. For roller bearings, low carbon, nickel, chromium, and chrome-nickel steels are used depending upon the service. Steels which are quite generally used for gears are low carbon, chrome nickel and chrome-vanadium steels, and it might be added that these steels properly case hardened give a more satisfactory combination of properties than is produced by the heat treated parts, although the expense is somewhat greater.

In the limits of a paper such as this, it is not possible to enumerate the many advantages aside from saving in weight, increased toughness, etc., which are derived from the use of special steels, but I wish to cite, in conclusion, a case which will show at least one of the possibilities.

This example is taken from the work of Guillet, the noted French metallographer. This steel was developed primarily to simplify the heat treatment and in fact it is simply necessary to heat the steel up to about 1550 deg. fahr. and allow it to cool in air. This treatment produces the desired properties in the same manner that the double heat treatment does for the carbon steels. The composition of the steel is as follows: C 0.75 per cent, Ni 3.82 per cent, Cr 1.28 per cent, Mn 0.52 per cent.

The properties are given in the following table:

	Tensile Strength	Elastic Limit	Elong. per cent	Elong. R. of A. per cent	Resistance to Impact
Annealed	138,000	110,000	12	40	3
Air Hardened	192,000	188,000	10	20	8

The elongation and reduction of area are less in the air hardened steel, but the resistance to impact is appreciably greater, showing a greater dynamic toughness, the property which serves better than any other to demonstrate the superiority of special steels over the carbon steels.

I wish to render my thanks to Mr. Wm. Howland, Jr., of the Illinois Steel Company, for information furnished me on the use of special steel in this country.

Very often the problems of the sugar industry do not touch so much on the design of new machinery as the adaptation of old machinery, and the increase in its efficiency, or duty, for a minimum outlay of capital. Nevertheless, a thorough knowledge of the principles of design and some actual experience in that branch of engineering are of incalculable assistance in solving the normal wet season problem of how to modify some apparatus to do better or achieve more work. Take the case of the multiple effect: this is one apparatus that is very often the capacity gage of the house; and given that the effect can be augmented in capacity, the other units can frequently be arranged to pass the increased volume of work.—Chas. E. Newbold, Mem.Am.Soc.M.E., in the ***International Sugar Journal, February, 1916.***

THE FUTURE OF THE ENGINEERING PROFESSION

BY A. J. HIMES,[1] CLEVELAND, O.

Non-member

THERE is a widely prevalent feeling among engineers that the material rewards for the practice of their profession are in general and relatively to other lines of endeavor disproportionately low. Much can be said both for and against this proposition, but I have chosen rather to recite certain adverse conditions affecting engineering practice and to advocate therefor a specific and definite remedy.

First: There is the age-long antagonism to exclusive knowledge for which Galileo and other scientists have suffered persecution. It is well for us to understand that this deep seated aversion of humanity towards everything new and difficult of comprehension is a natural instinct intended as a safeguard against impending danger. The more mysterious the danger, the greater becomes the alarm and the more completely do people lay aside the usual staid and dignified behavior and give way to frantic and unreasonable thoughts and acts.

So when the young college man appeared on the railroad with his curve formulæ and logarithms and a text book on track, the Irish section foreman took fright and instituted a violent and unreasonable warfare. He had held a good position—here was a man of youth and inexperience who held essential knowledge beyond Pat's comprehension and Pat feared his doom.

In the struggle which followed at least a few of the Pats became captains of industry, men who with the dignity and thought of maturer life still preserve an armed neutrality toward the presumption of one who finds in books the inspiration for a successful life.

Second: During recent years there have come to me many applications for employment from men of prominence in the profession, earnestly pleading for employment at any salary.

Third: In casual discussions among older men it is sometimes asserted that the engineering profession is an ideal myth; engineering is only a trade.

Fourth: In this age of research, investigation and compilation, when the world is richer than ever before in vast accumulations of knowledge, great multitudes of people are dying, suffering with disease and infirmity, blundering through life with failure upon failure, because this great accumulation of knowledge is not within the reach of those who feel its need.

These conditions indicate:

a. The need of the profession that the mists and cobwebs of medieval times be cleared away so people may see distinctly and understandingly the great benefits to be secured through the free use of experimental and scientific knowledge.

b. That the accumulated knowledge stored away in the archives of colleges and public libraries shall be disseminated among the people so that, being available, it may be used.

It is conceivable that if the dissemination and utilization of knowledge were a commercial problem, there would not be wanting men who would bottle it up in convenient and useful, perhaps tempting, form, and by means of immense distributing organizations place a day's supply on each doorstep every morning along with the breakfast cream.

People do not rise to the height of their opportunities. We complain of poverty when the world is full of everything good eagerly awaiting our use. If we could understand that the proper use of the works of scientific men would rapidly multiply our material resources, enabling all to enjoy comforts and happiness, as yet hardly hoped for, our energies would be bent more intently upon the *use of knowledge already acquired.*

The use of knowledge is the justification of engineering and our present controlling problem is the *extension* of that *use.*

Reverting again to commercial forms and putting the ideas in plainest terms, I would say, "Let's advertise." Unprofessional, apostasy, heresy may fail to express the shock this proposal will bring to certain ethical minds, but we must admit, in view of the conditions stated, something shocking and shaking and revolutionary is needed.

Advertising is a very old, conservative, well tried, respectable, and successful device for stimulating business. Is it less fitting that we should acquaint the public with the merits of our wares by description and explanation in print than that we should utilize paper and ink in our computations? Does an inventor bury his product in the earth less perchance some poor unfortunate shall look upon it and be saved? What does the Bible say about hiding one's light under a bushel? It is a barbarous idea that, locked in the secrets of his heart, a man should take with him to the grave knowledge that might be useful to his survivors.

The Cleveland Engineering Society has been advertising three years. Look at the record. Does it pay? The increase of membership has been 48.1 per cent. The increase of assets has been 37.7 per cent. Have we suffered in prestige or reputation?

On the contrary. The eyes of the country are upon us, watching our success and eagerly seeking to imitate it.

Assuming it is agreed by the profession to advertise, we arrive immediately at the practical question of intersociety relations. *There must be coöperation.* We must work together. A mass of broken stone will not cohere—it is friable; it falls apart. Mixed with cement it will support great bridges. So with men.

Farmers are notoriously independent in thought and action. They will not cohere and their influence is small. Cemented together with a vital purpose, they have on more than one occasion proved the salvation of the country. We must see that certain great achievements involve collective effort. We cannot stand alone.

The public does not quickly sense the fine distinction between engineers of different kinds and grades. It has neither patience nor ability to differentiate their needs. *In their relations to the public all engineers should stand together.* For this reason it is well that the local society should, within its field, marshall the full strength of the whole profession. Its local standing will be higher. Its interests will receive greater attention and consideration than would be possible if it were broken into several units representing different branches of engineering.

The preparation and utilization of advertising matter is so laborious and expensive that matter once prepared should be available anywhere. In this way, if all local societies were interested, the unit cost would be a minimum. A publication bureau supported by a number of local societies would be an efficient device for handling such business.

The national societies do not seem to be in a condition to join such an undertaking. They are ultra-conservative, and

[1] Chairman Valuation Committee, N. Y. C. & St. L. RR.

Presented at a Meeting of the CLEVELAND ENGINEERING SOCIETY, Cleveland, O., on November 9, 1915.

not inclined to coalesce. The function which they have filled so well in the past, of stimulating the publication of papers and their discussion and of conducting engineering investigations, is of prime importance and should be continued. As organizations there is small hope of aid from them in publicity affairs.

The increase of membership in local societies consequent upon a publicity campaign would undoubtedly increase the interest in national societies and stimulate their growth. For stability the growth must be from the bottom up and a more lively local interest in engineering would add greatly to the power and influence of the national societies. *If it were possible to combine all national societies in a single organization that in matters of legislation and public policy would represent the whole profession, the ideal condition of strength might thus be attained.*

The individual seeking employment may ask wherein this program may be of benefit to him. The answer may be found in a comparison to the development of travel. Make it possible to ride fifteen miles for five cents and travel will develop. Modern railroad trains and motor cars were inconceivable one hundred years ago.

Make the public familiar with engineering, its possibilities and limitations, teach the public how to use it efficiently and successfully and there will be no dearth of opportunity for engineering skill.

The temperature of the outside surface of a steam pipe is very nearly that of the (saturated) steam in the pipe. There is no appreciable difference in the temperature of the outside surface whether the pipe is bare or covered with a 1 in. layer of magnesia pipe covering. Therefore the conductivity of the iron in the pipe is so high that only a fraction of a degree of temperature drop between the two surfaces is needed to conduct through the metal all the heat that can be radiated from the outside surface of the pipe under almost any condition; also the rate of impartation from the steam to the inside surface of the pipe is so high that the metal is kept at the same temperature as the steam. This is undoubtedly due to the fact that saturated steam can give off a large quantity of heat by condensation without any change in temperature.

From the preceding deductions, it follows that in computing the heat losses through pipe coverings the resistance to the heat flow through the metal of the pipe can be dropped out of the problem and only the resistance of the covering material considered. That is, it is safe to assume the inside surface of the covering at the same temperature as the steam.

The above deductions hold true only for saturated steam. With superheated steam and hot water, both of which give off heat by drop in temperature, the results would very likely be greatly modified.—*Technical Paper 114, U. S. Bureau of Mines.*

No one thing has been more potent to contributing to the elimination of visible smoke than the advent of mechanical stokers and other forms of automatic furnaces.

Mechanical stokers provide for the progressive movement of the fuel into the furnace; they generally provide for an ample flameway and a brick arch under which the initial combustion may proceed. They are rarely installed except where satisfactory draft conditions are assured; as a consequence, it is commonly assumed that the mechanical stoker or hopper-fed furnace is a smoke-abating device, and in general this assumption is justified.—W. F. M. Goss, Mem.Am.Soc.M.E., in *Jour. Franklin Institute, March, 1916.*

ENGINEERS IN POLITICS

BY C. E. DRAYER,[1] CLEVELAND, OHIO

Non-Member

SPEAKING at the annual dinner of the Cleveland Engineering Society, last June, Mayor Baker said:

> The part that I like to think about in the Engineering Society is that its members, a good many of them, day after day and week after week, have contributed to the public good with no compensation coming to them, with no fame or no political aspirations, no particular recognition. . . . If the city had been required to employ those men it would have cost a great deal of money; and the results of the labor they performed freely are undoubtedly highly beneficial to us.
>
> In expressing my gratitude for that service, I, of course, speak as Mayor, and in doing so I express the sentiments of every citizen of Cleveland.

Lately we have heard a great deal from engineers about the lack of appreciation accorded their efforts by the public. Here a public official speaks in praise of the services of engineers as citizens, not in praise of their work as builders of material things. The building of railroads, canals, water supply and sewerage systems are fundamentally a public service, but they do not relieve the engineer of his other duties as a citizen. On the contrary the public character of his work creates new opportunities for civic leadership and increases his responsibility as a citizen. Even as the engineer is a product of modern times, so must he take his part in the solution of the human problems arising from his material achievements. Modern problems of citizenship are solved in most instances in the school of politics.

The intense seeking after technical knowledge in recent years and the great amount of work imposed by discovery after discovery in science, gave rise to a specialization among technical men until they lost in a measure sympathy with the people outside of their narrow field.

While specialization is necessary to scientific progress, there is need that we engineers study the relation of our occupation to the wider interests of mankind. Let us, as it were, break up the crystals of our old ideals, one of which is the time-honored precept that our achievements are sufficient witnesses to our ability, and see if the new crystallization does not take on a different form. Advertising, publicity, and politics may be commendable forms of activity if rightly practiced. The end to be sought must not be political preferment or personal reward, but service to the community. That is bedrock and cannot yield.

That the public is interested in the engineer is evidenced by the halo of romance that has been cast about him in literature. It will be far better for both the engineer and the public when the public learns that in civic affairs the engineer is an honest and efficient servant of the people, capable of taking administrative control.

Very recently a public official at the head of one of the engineering divisions of Cleveland told the author that the average councilman did not consider the *engineering* ability of the head of the department superior to that of a rodman or chainman, as the latter are *engineers* as well as he.

The implication of the public official who was a lawyer that the engineer could not be found with the judicial quality of mind to serve on the Interstate Commerce Commission would

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[1] Secretary of the Cleveland Engineering Society and assistant engineer, Valuation Department, N. Y. C. & St. L. RR.

Presented at a meeting of the ENGINEERING SOCIETY OF BUFFALO on December 15, 1915.

doubtless find general support today, for most people picture the engineer drawing hieroglyphic plans according to mysterious rules—he is silent and apart; his language is that of blue prints, and the desire of his heart finds expression before the public in terms of earth and metal, inanimate things.

As Berton Braley says, illustrating the talkativeness of "Leather Leggin's," the engineer:

When you need to dam a river or to turn it upside down,
Or to tunnel underneath it in the mud,
Or to bore an' blast a subway through the innards of a town,
Or to blow aside a mountain with a thud—
. . . .
Why you call on Leather Leggin's and he does that little thing,
An' then comes 'round an' asks you "Is that all?"

Our position with reference to the public is not unlike that of John Alden courting Priscilla for Miles Standish; let us speak for ourselves. And let us learn to speak where engineering principles are at issue with such clarity and vigor that in the trial of a case before the jury of public opinion we will get a unanimous verdict. We can.

Our training and habits have not endowed us with eloquent tongues, although the ability to talk well will be added when the awakening spirit impels us to reach up to our opportunities. But a channel by which our story can be favorably told the public lies within easy reach. There is a demand on the part of all people to know about the things which have a far-reaching influence on public welfare, on health and industry. So we find at our door an opportunity and a duty to place before the public dependable information about technical subjects.

What can the local society do? It can at least furnish through its committees and open meetings a forum where analytical minds can help solve problems about which engineers are qualified to speak. The engineering societies should be able to contribute to civic progress somewhat as they have to technical advancement. The same standardization of output cannot be effected, perhaps, and therefore many are discouraged.

Recently the Cleveland Board of Education set out to materially reduce the pay of teachers in our technical and commercial high schools. Its action was taken, notwithstanding the fact that the Cleveland Foundation was spending thousands of dollars employing experts in a survey of Cleveland schools and the subject of compensation paid teachers was receiving special consideration.

The Executive Board of the Engineering Society sent to the Board of Education a communication expressing its interest in the schools of the city and a desire to aid youth in procuring the best possible opportunities for education and self-advancement and petitioning the Board of Education to defer action until such time as legislation had been prepared to cover all steps that may be necessary to completely readjust the matter of compensation for teaching. We did not give a copy of this letter to the papers, but sent a copy to the Cleveland Foundation, as well as to the Board of Education. Action on salary cutting was deferred. It might be said that the Board of Education is hard put for money, but such economy as was devised was penurious and wasteful. It was our plain duty to keep the School Board from digging a pit and falling into it.

To the Mayor-elect who took office on January 1, we sent the following letter:

The Cleveland Engineering Society, being vitally interested in the welfare of Cleveland and the best administration of its public works, tenders you, through its Executive Board, its hearty coöperation in the advancement of the interests of the city.

Ordinances approved by the voters at the recent election call for the expenditure of many millions of dollars, much of which may be used to the best advantages of our citizens if proper professional knowledge and experience be employed in its administration. Many functions of municipal government, such as water supply, sewage disposal, street repairs and renewals, may be most economically and efficiently performed by men having engineering experience.

We recommend, therefore, that the positions of Director of Public Service and of Director of Public Utilities be filled by men having a broad engineering experience combined with administrative ability.

In this instance we gave the letter to the papers as soon as it was read before the Society in open meeting which was before it reached the Mayor-elect. One of the papers on the morning following gave the letter wide publicity in a manner above suggestion for improvement.

The Mayor-elect has appointed his cabinet apparently as different from our ideas as could be imagined. To be Director of Public Utilities, he appointed a labor leader who is graduated through labor councils from the waiters' union. To be Director of Public Service, he appointed a former councilman who is a lawyer. It should be said that it was not expected by the sponsors of this letter that its advice would be followed. But the chief object of the letter was accomplished, to place the principles before the public.

But how shall the public know that the engineer is a capable adviser and that the principles he enunciates are trustworthy? Education and acquaintance lead to mutual understanding. The most effective and direct method to bring about this desirable relation is in the use of the public print. It is not an exaggeration to say that the newspaper is the greatest educational factor, at least in its possibilities, of our present day civilization, and this takes into consideration the school, the college and the church. The more progressive editors recognize their responsibility and are opening their columns to signed articles by people of constructive ideas.

Referring to the civic activities of the Cleveland Engineering Society, Cleveland has been struggling lately with the revision of the building code. The actual work of revision was done by a joint committee composed of the Chairmen of the Building Code Committees of the Cleveland Engineering Society, Builders' Exchange, and the Cleveland Chapter of the American Institute of Architects. The code has been carefully studied by the Committee and some 460 sections have been revised and 260 new sections added, the City Council turning into law what the Committee approved. It has been a herculean task to which these men gave unselfishly of their time without remuneration of any kind.

The Civil Service Commission asked the Cleveland Society to assist it by taking charge of the preparation and marking of papers for engineering positions. Results to both the Society and the Commission have been very gratifying. The Commission secured the services of experts at no cost to the city, whereas during the previous year it had paid some $900 for examination of candidates for engineering positions, yet complaints had been made that proper relative weights had not been given to experience and theoretical training. The Secretary of the Commission told us that candidates were satisfied after the Engineering Society took charge. In this case our Publicity Committee tipped off the reporters and they dug up their own stories from the Commission.

Our first publicity work was in August of 1912, concerning the report of the Committee on Technical Education of

the Society after it had studied Cleveland's technical schools, and much publicity was devoted to arousing public sentiment against unnecessary smoke and to induce as many as possible to attend a popular lecture on "How to Burn Soft Coal Economically and Without Smoke," delivered by Dr. Breckenridge at a joint meeting between the Chamber of Commerce and the Engineering Society. The meeting was attended by 600 engineers, manufacturers and citizens.

Later the Bridge and Grade Crossing Committees of the Society found little had been done in planning the work of grade elimination in the city in a systematic manner and recommended that future work be anticipated in some general comprehensive scheme.

An aeroplane article that appeared in a Sunday magazine section was our first feature article. Attention was called to the meeting by an advance notice of the meeting, consisting of a picture of the speaker and some 100 words telling about him and what he was to talk about. When we went to the Sunday editor and asked him if he'd like a feature article on flying machines, he said, "Yes, only you engineers are too technical." We told him we were interested mainly in knowing whether he was receptive to the idea and that he didn't need to print the article if it didn't suit him. "That's a go," he said.

The Chairman of the Publicity Committee has been seeking the right sort of an assistant for a long time. When he found a young man ready to attempt the preparation of this article under his direction, he felt about the young man as the editor did toward the article—he might come through, but past evidence was to the contrary. The article was blocked out. The writer came back with a sophomoric composition, a good undergraduate essay. We went over it in detail and he rewrote it, improving it considerably and approaching newspaper style. Again it was given back to him to rewrite. He did it over the third time and never flinched. The editor was highly pleased. Now both our Sunday papers are eager for our feature copy and one article has been paid for. Pay had been offered us previously, but we then told the editor the material was not for sale. The effect this statement produced upon him was worth the sacrifice in money.

We stated before that any plan for publicity by engineers must be based on a systematic scheme to educate the public. From the standpoint of the engineer, the public includes the men who make the newspapers. For instance, an article entitled: How Gunners Pick Their Target Though Far Away, might just as well have been captioned: Long Range Trajectories. Had we attempted such an article in the early stages of our publicity work, the editor would have been inclined to view the attempt as too technical. Indeed, a good many engineers would be prone to say that the subjects of trajectories and ballistics are too involved to be understood by the average reader of the daily newspaper. After the article was published and opinions expressed as to its value, the Sunday editor wrote us characterizing the article as a "knockout" and asking if we couldn't write him another soon.

While no positive statements are made in the article, whether the Germans with reasonable care could have avoided the destruction of historic and sacred edifices in the cities they were bombarding with cannon located 20 miles away, no great acumen is required of the reader to judge correctly. The editors of both papers have expressed appreciation of the line drawings to make the text clear. We furnished text and diagram, while the newspaper furnished the "filling in" with pictures and sketches.

An article entitled: Why No Boat Can Withstand a Torpedo, was devoted to an explanation of the principles of buoyancy governing the design of ships.. By picturing the difficulties an urchin meets in trying to keep a floating tomato can upright until he discerns that he must put some stones in the can, very technical terms like center of gravity, center of buoyancy, and metacenter can be introduced without frightening the nontechnical reader. Even an engineer came to us and told us that he enjoyed the article and learned several things from reading it.

Touching upon the point of timeliness of news, this article was cast for the presses when the Eastland capsized. One of the editors accused us of being accessories before the fact. In defense we would say, had the Eastland turned over a week earlier the caption would doubtless have been different. In this article, as in the gun pointing one, we furnished the text and diagram, the paper the "filling in." It was syndicated by the paper that published it, but no division of receipts was made with the Publicity Committee. We are going to try a little syndicating of our own in the no distant future.

The ability to meet new conditions with new methods is an ordinary attribute of the engineer. This was featured in an article on: How a Railroad Was Saved from Burial. This article describes how a railroad engineer stopped an earth slide by blowing up into a barrier the soapstone on which the superincumbent earth was slipping. The feat was performed on a railroad connecting Cleveland and Pittsburgh, hence had local color common to both cities. The story as published in a Pittsburgh paper was furnished by the Engineers' Society of Western Pennsylvania.

With the local story as a "news peg," several earth movements of interest were reviewed, some that had happened several years ago, and which had been written up in the newspapers at the time. It may be truthfully inferred that ancient history may be made into news.

The Good Will Number of the Journal of the Society is an argument for universal peace, but makes no reference to the present cataclysm in Europe. It is based on the idea that modern war is a mathematically scientific game played with deadly machines evolved by the engineer. With the same scientific principles in mind, if the efforts spent in war were turned to the works of peace—in peaceful rivalry instead of destruction—a tremendous advance in human welfare would be the result. The Publicity Committee sent copies of the Good Will Journal over the country, wrote reviews of it for periodicals and distributed several hundred copies to citizens of Cleveland, and placed them in downtown offices of physicians and dentists, libraries and the like, where they would be read by many people.

Engineers Are the Men Who Make Dreams Real. This was suggested as the subject of an article by the Publicity Committee to one of the sub-editors who was charged with writing an interesting story for each Sunday. Naturally the most difficult part of his task was to find a subject and material. We arranged for an interview with an engineer who could talk in an interesting manner to a reporter. The definition of "engineer" the newspaper evolved is rather apt. "An engineer is a man who somehow, some way, tames the forces of nature, helped by science, and makes them do man's bidding."

At a time when the electrification of railroads entering Cleveland was being agitated, the Engineering Society invited N. M. Storer, of the Westinghouse Electric & Mfg. Co., to lecture on the subject. The meeting was held at Case School and was attended by several of the city officials.

On a Tuesday evening, our regular meeting night, we had three newspaper men tell us about the making of a newspaper. One spoke from the standpoint of the editor, a second about the business and advertising end, and a third, a member of our society, gave the principal address which was devoted to the power presses and other machinery of a newspaper plant. On the following Saturday afternoon we visited the largest three plants in the city, each within a few minutes' walk of the others. The Press took our pictures just after we had started through its building and in 42 minutes had the paper printed ready to hand to us as we left.

A very pleasant and profitable custom of visiting back and forth has grown up between the engineering societies of our section. We have visited the Engineering Society of Pittsburg, Buffalo, and Detroit, and plan a trip to Toledo. The Detroit engineers on September 11 returned our visit of last spring.

I am inclined to place greater value on the social and good-fellowship part of these programs than on the professional benefit gained from visiting plants in other cities, large as that may be. Trips by boat are effective in getting members acquainted with each other, out of which grows a common interest.

An article entitled Bridge Foundations a Mighty Problem, properly may be classified as service to the community. The building of the foundations of a great high-level bridge, the main artery between two parts of Cleveland, gave rise to a lively controversy as to their safety. The public had a right to know the truth. The county bridge engineer was asked to read a paper before the society describing the foundations. His paper was abstracted with technicalities omitted or so worded as to be understood by the reader of average education, and published in one of the papers on the Sunday following the meeting.

An article entitled: Local Men Will Be Prominent in American Electric Railway Association Meeting, appeared in the sections of our papers devoted to railroads. The longest article that appeared was signed by the railroad editor, and the text is verbatim as we prepared it. Railroad Engineers Conclude Convention was the title of a telegraphic report sent from Chicago, press rates collect, to the Cleveland papers after one of the railroad editors had suggested that we do it. When Hunter McDonald, then president of the American Society of Civil Engineers, was being mentioned as possible head of the construction forces for the Government's Alaskan railroad, an excellent "news peg" was at hand on which to hang quite a story about the American Railway Engineering Association and American Society of Civil Engineers.

Shortly after the new weather forecaster took up his work in Cleveland he became a member of the Engineering Society. It was quite proper that both the man and his lecture on the U. S. Weather Bureau and Its Work should be given some publicity, introducing him to the community. Cleveland is in a district subject to so many and sudden changes of weather that the lot of the weather man is a precarious one.

When we came to write the advance notices, we got down our cyclopedia and discovered some interesting things, one of which was that a Clevelander while in Congress had a hand in the formation of the Weather Bureau. This and several other interesting points were ancient history, unless there could be found a "news peg" to hang them on, that is, to justify them. The new weather man and his lecture was the peg.

As to publicity work done by other local engineering societies, in St. Paul a special committee of the Engineering Society made a careful study of the depot approaches and traffic distribution. The report was published in the daily papers in advance of the meeting in order that engineers and the public generally might be fully informed and be prepared to discuss the report at the meeting.

In Buffalo, an arrangement was made with one of the papers whereby the equivalent of two columns of space in the Sunday issue was placed at the disposition of the Engineering Society. Several columns, of which Mr. Swasey's picture is a part, set forth quite fully information about the Engineering Foundation and its possible uses and was published on March 21, nearly two months after the dinner at which the gift was announced.

Space obtained for this subject by the Publicity Committee of the Cleveland Engineering Society consisted of the two 6-in. items headed: "$200,000 Gift for Science" and "Swasey Aids Science." These placed alongside the Buffalo article for contrast illustrate graphically a fundamental law of newspaper work. It is to be borne in mind Mr. Swasey is a Cleveland man. If information had been available three-quarters of a column would have been used to announce an event of such importance as the Engineering Foundation. Our efforts by letter and wire brought nothing to the papers the night of the dinner but the next day, after the papers to which it was addressed were out, there came a long wire from the engineers in charge of the function. From the standpoint of news, the message was then ancient history.

In other words, news is a commodity of a most perishable nature. Unless the time element is clearly understood, a good item may be lost due to its reaching the paper an hour late.

Early in our publicity work there was published in one of the local papers a letter from a young man to the editor asking what the opportunities are in civil and mechanical engineering. The editor printed below the letter a request that engineers of each of these branches answer the question. Of course, we are amused that anyone should expect the editor of a daily paper to answer the question, but the asking indicates at once the opportunity to perform public service through the medium of the daily papers.

Here was an opportunity for the Publicity Committee. It accordingly asked the President of the Society to prepare an article in answer to the question to be offered to the editor of one of our papers. The editor liked the idea so well that he called for more, and the series grew until there were fourteen articles. These articles with a few on the branches not treated in the Cleveland series have just appeared in book form, Engineering as a Career, from the press of D. Van Nostrand Co.

In any local engineering society there are men pre-eminently qualified to tell the young man what the opportunities are in the engineering profession and what is required in the way of training to succeed. Thousands of youths, their guardians and parents would eagerly welcome such advice, but they don't know how or where to get it. We are of the opinion that such a series as was run in Cleveland could be written in any engineering society and that the papers would gladly share in the opportunity to place such dependable information before the community.

There are several ways that may be used by engineers to educate the public besides the public press, where an un-

sympathetic editor may inhibit our efforts. The Engineers' Society of Pennsylvania has conducted Industrial Welfare and Efficiency Conferences to the evident satisfaction of all participants.

As soon as time permits we plan in Cleveland to enlist a few of our younger engineers to give illustrated lectures on engineering subjects before small gatherings in churches, schools, libraries and the like. It is hoped that a sympathetic understanding of engineering knowledge and skill can be brought about more quickly by a personal contact of this sort. In addition, the speakers will gradually acquire by practice that facility of expression on their feet which is necessary in order that we may argue on equal footing subjects in dispute before legislative bodies or large gatherings of citizens.

It is evident that the first missionary work must be done among engineers and that the measure of our progress in civic activities will be determined largely by our working together, not only in communities but everywhere—in a word, Engineering Coöperation.

The experience which has been gained in one society should not only be the common property of all, but the peculiar conditions existing in each place should be interterpreted so that general principles may be formulated. For instance, in Philadelphia the local sections of national societies are affiliated with the local society. In Detroit the quarters of the Engineering Society are rented to local sections, but coördination of effort is still to be worked out. In Cleveland the formation of sections of the national societies comes about slowly because it is felt that the local society fills the field. Here are suggested the large questions:

Can the interests of the national societies be best forwarded by having local sections in affiliation with or separate from the local society; and, on the part of the local societies, do local sections of the national societies tend to strengthen or disintegrate the local organization. The author inclines to the opinion that interest in the local society is the parent of prosperity in the national organization.

It seems apparent that the interests of all engineers and technical men have so many points in common—dovetail, as it were—that in any community there should be one home for all and that along certain lines all shoulders should be to the wheel for the best interest of the community and the engineering profession.

It can be truthfully said that legislation has often failed to take the constructive form favorable to public interest, and largely because the engineer has not taken his just responsibility as a citizen. To what extent should we enter politics? It might be rashness to enter actively in political campaigns as yet, for the stage is not properly set nor are the actors trained to reach the audience in public debate. But in matters of pending legislation, the lawmakers are ready to listen to what engineers say. In Cleveland the present Mayor would, I venture, not think of appointing a committee of citizens where engineering principles are under consideration without selecting a due proportion of engineers, and that after asking for nominations by the board of the Society. Our recently appointed City Plan Commission is headed by a member of our Society. Two out of three members of the committee having charge of building our new $2,000,000 library building are members of our Society.

Licensing of engineers by states is advocated in many quarters, by engineers as well as by the public. This is a subject for consideration in a broad minded and unselfish way—Engineering Coöperation.

To sum up, in the discharge of his ordinary duties the engineer is usually contributing to the substantial advancement of the community. Yet there remains a large undeveloped opportunity for him to aid in promoting public welfare.

The age of selfish, although valuable, specialization is giving way to the age of coöperation. The engineer at once has the right and rests under the obligation, because of his training and ability to act as leader in the changing conditions.

If we are to make progress along the course just outlined, the engineer and the public must first get well acquainted. There must be a systematic direction and education of the public to a realization that in civic affairs the engineer is an honest and efficient servant of the people.

Let me add one thought in closing. Suppose we engineers should publish regularly a magazine devoted to engineering written in such a manner that it would be attractive to the intelligent layman. To make the idea concrete for comparison, make it something after the standard of the National Geographic Magazine but devoted to engineering, controlled and published by engineers. Would it not contribute more than any single thing we can do to advance the interests of both the public and the engineer?

We in Cleveland plan to get out a special issue of our Journal in 1916 tending toward the ideal pictured above. Suppose engineers in Buffalo, Detroit, Boston, Philadelphia, Pittsburgh and elsewhere should contribute copy, and that the engineering societies of these several cities should buy and give away in their cities, as we did our Good Will number of our Journal in Cleveland, only a thousand copies each. Then suppose the idea grew and we published regularly to paid subscribers a magazine that would bridge the gap between the engineer and the layman. Who has the imagination to measure the future? Let us think on it.

In 1914-15, the first year of operation, 1,317 ocean-going vessels passed through the Panama Canal. This included commercial, naval, and pleasure vessels. The aggregate net tonnage, according to the Panama Canal measurement, was 4,596,644 tons, and the aggregate gross tonnage 6,494,673 tons. The average net tonnage per vessel was 3,490 and the average gross tonnage 4,931.

Very considerable attention has been given to the composition and treatment of tool-steel for machine tools, but the three implements of the hand worker—the file, the chisel, and the hammer—have been comparatively neglected. Important work has recently been done in testing the former of these, and there is little need of improvement with the last-named, but it is believed that the chisel has not received the systematic attention its importance deserves.

The material usually employed for chisels is not ordered by specifications, but a well-known and tried brand purchased. After considerable experiment it was decided to order chisel steel to the following specifications: Carbon, 0.75 to 0.85 per cent; manganese, 0.30; silicon, 0.10; sulphur, 0.025; phosphorus, 0.025.

The analysis of a chisel which had given excellent service was: Carbon, 0.75 per cent; manganese, 0.38; silicon, 0.10; sulphur, 0.028; phosphorus, 0.026. The heat treatment this chisel received was unknown.—*Jour. Inst. Mech. Engrs., February, 1916 (February 18 meeting.)*

In the modern high-speed steam and internal combustion engines, cast iron is, up to the present, the only metal which has given satisfactory working results when used for the construction of certain vital parts, such as pistons, piston rings, and cylinders. This fact, coupled with the serious drawbacks of cast iron in other ways, is sufficient to prove the tremendous importance of a careful study of the subject.

The two chief properties required of cast iron for the purposes named are maximum resistance to wear, and the most perfect running properties under the conditions existing in the engine. The mechanical properties, such as tensile and transverse strength, can usually be obtained sufficiently high to withstand the stresses involved in the use of the generally accepted thickness of material. The modern tendency, however, seems to be to cut down the weights of members, and for this reason higher tensile strength irons will be more and more in demand.—*Engineering, February 18, 1916.*

One of the most important problems that has to be solved by any organization is the problem of pay. This is especially true of an organization operating under scientific management. In the first place, there has been so much discussion of the matter that the men who became members of the organization are prone to be critical upon the subject. Another reason is that the education of the workers under this type of management occupies so much time, and is so expensive, that it is a decided loss to have a trained man leave because of dissatisfaction with his pay. The third is that this type of management depends absolutely for its permanence and success on the spirit of coöperation that exists. Finally the pay system under the scientific type of management is scientifically determined.

The problem of pay is one upon which close attention must be continually concentrated. When this pay problem based on time study is solved to the satisfaction of all concerned, an important part of the success and the permanence of the installation of scientific methods of management is secured.—F. B. and L. M. Gilbreth, in *The Iron Age, March 9, 1916.*

The temperature of a boiler tube is within 10 to 20 deg. cent. the same as that of the boiler water, and the temperature of the tube is affected very little by the temperature of the hot gases, but follows the temperature of the boiler water.

As the temperature drop along the path of heat travel is nearly proportional to the resistance to heat travel, the resistance appears to be very high from the hot gases to the gas-side surface of the tube and very low from this surface to the boiler water. This fact indicates that a boiler tube can transmit very easily all the heat that can ever be imparted to it by the hot gases, and that as long as the tubes are kept free from scale, oil and other deposit, and filled with water, it is impossible to overheat the tubes, no matter how hard the boiler is worked.

The slow part in the path of heat travel is from the hot gases to the boiler tube. It is this part of the path that is responsible for the slow rate of heat transmission in boilers as now designed and operated. Anything that will increase the rate of heat impartation by the hot gases to the boiler tube will almost directly increase the rate of working of the boiler. This is an important fact and should be kept in mind by the designer when designing a boiler which is to be operated at high capacity.—*Technical Paper 114, U. S. Bureau of Mines.*

CORRESPONDENCE FROM MEMBERS OF THE SOCIETY

Provisions have been made by the Publication Committee for Correspondence Departments in The Journal as follows:

A Department for contributed discussions on papers previously published, or new matter.

A Members' Correspondence Department including suggestions on Society affairs.

Contributions for these departments are earnestly solicited.

TURBINES VS. ENGINES IN UNITS OF SMALL CAPACITIES

To the Editor:

In the paper on Turbines Vs. Engines in Units of Small Capacities, by J. S. Barstow, published in the September issue of The Journal, a statement is made in the last paragraph that engines are particularly applicable for condensing units where the condensing water supply is limited and where the water must be recooled and recirculated.

A compound condensing engine or a single cylinder uniflow engine has high efficiency—that is, utilizes a large share of the available energy between the terminable pressures, provided the exhaust pressure is not too low. A vacuum of 26 in. is about as high as it pays to go with an engine. Now where water must be recooled by a spray pond or a tower, very high vacuums are not attainable because of the physical and commercial limits to the temperature to which the water can be cooled, to say nothing of the cost of pumping the water if a large quantity is circulated. Thus the reciprocating engine has a field of peculiar applicability in plants of this kind.

The steam turbine is at a disadvantage under these conditions of moderate vacuum. In a turbine the efficiency of conversion of energy of the steam into mechanical energy is greater, the lower the existing pressure. High vacuum is doubly important to the steam turbine—to furnish more energy and to furnish energy which can be abstracted most efficiently.

The turbine is cheaper than the engine, requires less space and foundations, is cheaper to operate and can be built in larger units than the engine, and therefore it is pertinent to inquire how far it is possible and profitable to go in obtaining high vacuum, so as to reduce steam consumption to that of the engine.

The higher the vacuum, the greater the power of the auxiliaries (and it is to be remembered that the circulating water is pumped against considerable head) and the greater the fixed charges for the condensing and water cooling apparatus. These charges offset the gain in the turbine. The critical vacuum varies with conditions, but is usually found to be around 27 in. vacuum for atmospheric conditions of 75 deg. and 70 deg. humidity. The chart of Fig. 1 is taken from an article by the writer in Power, of November 11, 1913, entitled: Best Vacuum with a Cooling Tower. It shows that there is a saving of \$200 per year by increasing the vacuum from 26 to 27 in. for a 500 kw. turbine with \$3.00 coal, 50 per cent load factor and other assumptions given in the article. Further investment, however, to obtain a higher vacuum, actually results in a smaller gain, until at slightly over 27½ in., the net gain (above 26 in. operation) is nothing. The increased fixed charges and operating cost wipe out the gain in turbine economy.

Let us assume steam conditions of 175 lb. pressure, 100 deg. superheat and 26 in. vacuum for the engine and 27 in. vacuum

for the turbine. The engine efficiency referred to the Rankine cycle may be taken at 70 per cent and the turbine efficiency at 65 per cent. We then have the following:

a Reciprocating engine, 26 in. vacuum.
Theoretical steam consumption, 7.8 lb. per br. h.p.
Actual steam consumption at 70 per cent efficiency, 11.15 lb. per br. h.p.

b Turbine, 27 in. vacuum.
Theoretical steam consumption 7.4 lb. per br. h.p.
Actual steam consumption at 65 per cent efficiency, 11.40 lb. per br. h.p.

There is a difference of 0.25 lb. per br. h.p. in favor of the engine, to which must also be added the difference in power consumption of the auxiliaries.

The average turbine efficiency of 65 per cent corresponds approximately to an efficiency starting at 55 per cent at the high pressure end and increasing to 75 per cent for the wheels operating in high vacuum steam. If it were profitable to install

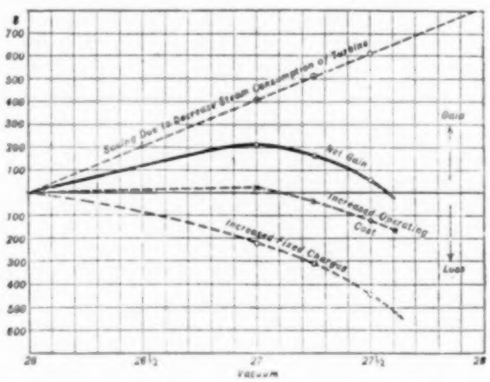

FIG. 1 DIAGRAM INDICATING SAVING DUE TO INCREASE OF VACUUM

cooling tower equipment for 28 in. vacuum (for the same atmospheric conditions), the increase in available energy would be 20 B.t.u. per lb., of which 75 per cent would be utilized by the turbine and as the energy available at 27 in. vacuum is 344 B.t.u., the percentage gained in output would be 75 per cent x 20 ÷ (344 x 65 per cent) = 6.7 per cent, and the steam consumption would be reduced from 11.4 lb. to approximately 10.63 lb.

Now suppose that the turbine is operated with only half of the steam expanded to the 28 in. vacuum, and the other half expanding to the original 27 in. vacuum conditions. No additional investment in condensing or water recooling apparatus would be needed. The steam consumption would be the average of the two figures given, or

c Turbine, vacuums of 27 and 28 in.
Average steam consumption 11.02 lb.

This steam consumption is slightly lower than that of the engine; the difference 0.13 lb. would offset the greater power consumption of the condenser auxiliaries required with the turbine, as compared to the engine equipment.

In order to condense the steam exhausted from the turbine at two vacuums, a two-stage condenser is necessary, as shown in Fig. 2.[1]

Ordinarily the condensing water is heated to its final temperature in one step while condensing all of the steam at 27 in. vacuum. In the two-stage condenser it is heated through the first half of its total rise while condensing half of the steam at 28 in. vacuum, and through the final half of its rise while condensing the remainder of the steam at 27 in. vacuum. The size and cost of the cooling tower, the amount of water circulated and the cost of pumping, all remain the same.

Half the steam is condensed at 28 in. vacuum in the upper section (Fig. 2) and the other half at 27 in. vacuum in the lower section. The air is withdrawn from the high vacuum section by steam jets which act as augmenters to improve the vacuum by withdrawing the air in a very rarified state, at the same time reducing the amount of condensing surface necessary. Another feature of the construction is the arrangement for heating the cold condensate from the upper part of the condenser by bringing it into contact with steam in the lower part of the condenser. All the condensate is thus returned at the temperature of the hottest steam.

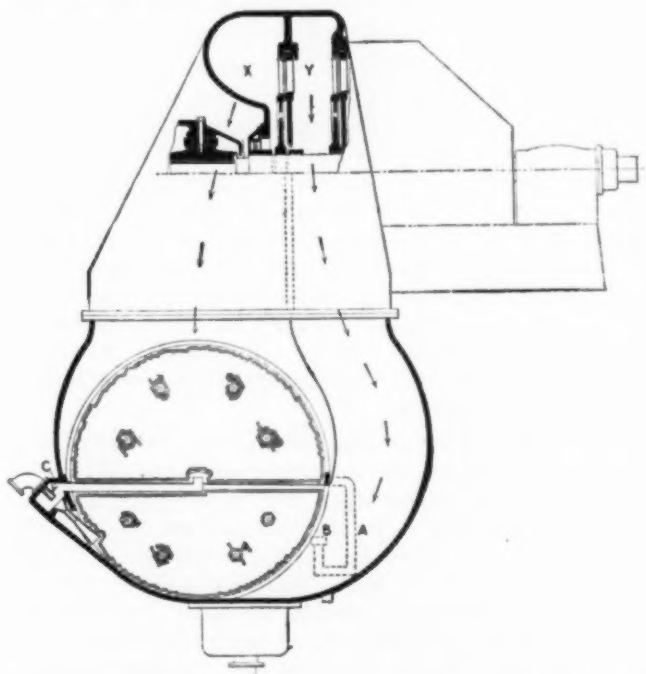

FIG. 2 TWO STAGE CONDENSER FOR OPERATION IN CONNECTION WITH A TURBINE

The decrease in turbine steam consumption from 11.40 lb. per h.p. to 11.02 lb. per h.p. is obtained without added cost of cooling tower or spray pond, pumps, piping or condenser. It is true that even this recooling and condensing equipment, which is the same size as that required for standard 27 in. vacuum operation is more costly than that for 26 in. vacuum with the engine, but on the other hand the engine is more costly than the turbine.

The two-stage condenser is also applicable to plants having a natural supply of water. Take for example a turbine and condenser installation for 28½ in. vacuum with 70 deg. water. Half the steam can advantageously be expanded to 29 in., making a gain of a very valuable half inch of vacuum on half the steam. The efficiency of a complete turbine of a large size may be taken at 75 per cent. The efficiency of the last blades is 85 per cent or more. The percentage gain in power per pound of steam is found to be one half of 5.7 per cent or 2.8 per cent for steam conditions of 200 lb. pressure and 150 deg. superheat. With a 10,000 kw. turbine this is worth from $2000 to $5000 per year, depending on coal price, load factor, etc.

New York, N. Y.

PAUL A. BANCEL.

[1] See article in *Power* on The Two-stage Condenser, Sept. 21, 1915.

THE DIESEL ENGINE AND ITS APPLICATIONS IN SOUTHERN CALIFORNIA

To the Editor:

In view of the high value and profit that can accrue from a correspondence department dutifully supported by the members of the Society, I feel it incumbent upon me to offer my contribution to this good work on an occasion when so many others will perforce not find scope to assist. I have had some reluctance to overcome, for I have so frequently refrained from comment when the oil-engine and particularly the Diesel oil engine has been the subject of wrongful or inaccurate statements, that I fear to be thought guilty of an ulterior motive in selecting Mr. Adams' paper for criticism. The explanation seems due to Mr. Adams that his errors occur when he has had to rely for guidance upon printed sources, not aware that much is published which arises from ignorance.

Referring to the statement in the paper by Mr. Adams, that "air inlet and exhaust valves are not required," it is more usual to find the flow of scavenging air controlled by valves. Of only three designs can it be said that the exhaust valves and air admission valves are absent. Between the extremes there occur two interesting intermediate styles: *a.* the Sulzer fashion, in which the scavenging air is admitted through ports at the base of the cylinder, but with a positive cut-off in the shape of a valve controlling the flow of air to the ports, and *b.* the Sabathé mode, in which part of the scavenging air enters through ports and part through a valve in the head of the cylinder. The trend is markedly towards the control of scavenging air by valves.

The statement that "in marine work the reduction in number of valves makes it easier to reverse a 2-cycle engine" is ambiguous. The probability is that this remark will generally be interpreted as an assertion that the 2-cycle Diesel engine is easier to reverse than the 4-cycle engine, which would be a sorry impression to give. What has been the least simple reversing mechanism applied to any Diesel engine has been that fitted to all the Carels 2-stroke sets. On the other hand the small Polar 2-cycle sets have had a simpler reversing device than any other engine has possessed, but this is not true of the larger Polar engines, such as were for a while in the tankship Sebastian.

Again while the designs of the M.A.N. 2-cycle submarine engine (as exemplified in NLSECO construction, for instance) and of the FIAT submarine engine show extremely simple reversing mechanism, they do not derive it from having fewer valves than the 4-cycle type possesses, for they have two scavenging valves, besides the injector and the starting-valve. By contrast, the larger Polar engines (Sebastian type) have no scavenging valves in the head, but their reversing mechanism is not simpler than that of the 4-cycle engines.

There is no general rule governing the case, and the most that can be said to the favor of the 2-cycle engine in this regard is that it *can be adapted* to have a simpler reversing mechanism than the 4-cycle engine can possess. I have preferred to refer to "simplicity of mechanism" rather than to "ease of reversing," because all the marine Diesel engines of any credit reverse very easily. Mr. Adams' phrase suggests a different state of affairs.

Literally it is correct that "the use of the 2-stroke cycle has also made large units possible," and that 1200 h.p. per cylinder in a single-acting engine has been built, but without the qualifications that would show the limits of this statement, the remark is misleading. Would it not be thought by Mr. Adams' audience and circle of readers that the large 2-cycle unit is a commercial realization and not merely the experimental production which it is at present? Would it not also appear that Mr. Adams had indicated the maximum cylinder power yet furnished in the experimental construction of the large European firms?

As a matter of fact, Sulzer's have been making trials with a single-acting unit which develops about 2000 h.p., but of which I cannot quote either the maximum "overload" power or the "normal" test-bed output. And in the double-acting style of construction, which it seems appropriate to mention at this place, over 2000 h.p. per cylinder has been attained in the experimental sets of the Krupp shipyard and of the Nuremburg works. Yet, of all this costly effort no practical, commercial result has been born.

The Sulzer factory has made a great showing of orders for 2-cycle Diesel engines of considerable power and has made some deliveries. If the six-cylinder 4000 h.p. engine for the Harland & Wolff shipyard at Belfast has not been erected and started in regular service then the largest 2-cycle engine operated in independent service is a four-cylinder 2400 h.p. set by Sulzer. How trustworthy such engines are in their particular service has not yet been established by independent testimony. If they are not worked for long periods or under continuous full load they probably are satisfactory, but that they can develop full power and assume occasional brief overloading during uninterrupted periods of 300 hr., or even of 200 hr. we know from marine experiences to be improbable. The largest 2-cycle engines that have rendered in marine service the equivalent work and satisfaction of steam machinery are the four-cylinder 800 b.h.p. sets in the "Monte Penedo," these sets also being of Sulzer construction. The famous Swiss firm has achieved more in the development of the 2-cycle Diesel engine than any other factory has to its credit.

And here comes a further qualification of Mr. Adams' remark that "the 2-stroke cycle has made large units possible," a figure of 335 h.p. per cyclinder having proved thoroughly successful in a single-acting engine under arduous marine conditions, this being to the credit of the Burmeister & Wain works of Copenhagen, while moreover in the 4-cycle double-acting tandem design the development has proceeded to 2000 h.p. per crank-throw, not in an experimental shop engine, but in the Augsburg engine delivered to one of the compressed air stations in Paris.

Will Mr. Adams state that cylinders of 50 in. diameter will not prove satisfactory in 4-cycle engines and will he aver that the tandem double-acting style of construction does not alter the cost comparison between the two types, to which he refers in the early part of the paper? The man who will to-day venture on a prophecy of the outcome of the battle between the cycles has much to learn. Design, it is true, produces occasional advances in technics—witness the heat shield conceived during the collaboration of the engineers of the Blohm & Voss shipyard and of the M.A.N. Company, several interpretations of which are being tested on the six-cylinder 2000 h.p. engine at the Brooklyn Navy Yard.

It is, however, to metallurgical science that one must turn prayerfully for assistance in striving to overcome the difficulties presented by the large Diesel engines. To speak of the number of heat units passing through a unit of surface in the space containing the burning or burnt gas is to divert attention to problems overcome. All is well where the heat units pass; the troubles come where the heat units accumulate and do not pass. To think in averages does not help one

here; reflection rather must be directed to the extreme conditions.

Can Mr. Adams name sailing vessels in which Diesel engines have been installed other than: Stein, Orion, Fram, Cornelis, San Antonio, Sound of Jura, Quevilly, France, a small Italian schooner and a German training ship (a Danish training ship now building is to have a Diesel engine)? There are a few other small craft in which pole masts are stepped for a small spread of canvas to stiffen the vessel in a nasty cross-sea or to assist in quickening a passage before the wind, but they do not handle properly under canvas alone and cannot thus be classified as "sailing vessels." Of the craft enumerated, only the Quevilly, France and two training ships exceed 500 tons, and of these the first-named has had her machinery removed. Under particular local conditions an auxiliary vessel can be profitable, but the concensus of opinion, backed by general experience, is that such a craft does not suit the economics of remunerative ship-owning. Hence the very small number of Diesel engines installed as auxiliary power in sailing vessels.

The very first engines built at Augsburg to the order of customers were entirely satisfactory, and the patriarch of of them all was doing its daily work at a match factory in Kempton, Germany, when the war started—and probably nothing has since interferred with its satisfactory operation. As in all branches of mechanical construction, the Diesel engine industry has known factories that could not, or certainly did not, produce as well as they should have done, but these have prevailed more of later years than at the start. Occasionally one of the leading firms has gone astray, sometimes effecting a quick recovery, but sometimes—more's the pity—remaining a confirmed delinquent for long. To relate what was done that was bad and to show how much was done that was good would carry one through the whole crowded history of the Diesel engine. In sum, however, it may be stated that most of the work has always been good, and it is totally wrong to believe that "engines giving satisfactory service have only been made in Europe within the last five years." As if any type of engine could survive 13 years of unsatisfactory service in the competition of modern days!

There would have been considerable advantage in adding to the footnote a reference to the 1914 paper by Mr. Setz. There has not been published in this country any exposition of the Diesel engines which is sounder in its consideration than this monograph by Mr. Setz. It expresses mature opinions and displays a fine, clear sense of the fundamental factors which should rule all reflections about the Diesel engine. The 1911 paper by the same author should not be read until after the later article has been studied.

Not having at hand the references which would enable me to quote the cylinder dimensions of the smallest Diesel engine that has been marketed I can amend Mr. Adams' citation only by the bald assertion that the Delaunay-Belleville establishment, of Paris, exhibited at the Turin exposition, 1911, a single-cylinder 4-cycle unit developing 5 h.p. at about 500 r.p.m. Mr. Louis Nobel has furnished from his Petrograd factory to the Russian Imperial Navy, 50 h.p. four-cylinder 4-cycle sets to furnish the propelling power in the diminutive submarines of 50 tons displacement commissioned about 1911 or 1912. He has supplied similar sets for other purposes also. The Polar firm at Stockholm has a special tool equipment for the production of the 12½ h.p. 4-cycle cylinders which it builds into units or sets as required. The Daimler Engine Co. constructed at the Marienfelde Works, near Berlin, a considerable number of 65 h.p. four-cylinder 4-cycle motors for boats of German ships-of-the-line. Also at Berlin, the A.E.G. had begun the production in quantities of 25 h.p. two-cylinder 2-cycle engines direct-coupled with generators. Sulzer's even have not ignored the possibilities of the small Diesel engine. Not one of these small sets enumerated has cylinders larger than those quoted by Mr. Adams as the lowest of which he had knowledge. Several of them have cylinders appreciably smaller and all have a lower rated power at their respective high speeds.

The higher limit is reached certainly in the 2000 h.p. single-cylinder built by Sulzer for trial; this, being operated on the 2-stroke cycle, has a cylinder diameter of probably about 44 in. In all likelihood, the big Krupp & M.A.N. double-acting sets with about 2000 h.p. per crank have a larger cylinder diameter than that quoted by Mr. Adams for the Carels engine. This latter is given as developing 1250 b.h.p. and its mean effective pressure as 106 lb. per sq. in. Obviously this should read 1250 i.h.p. and 106 lb. per sq. in. mean indicated pressure, if the complementary figures are correct. One may also observe that to obtain even this indicated power a piston speed of nearly 1000 ft. per min. is utilized and the mean pressure is not such as Carels have ever succeeded in maintaining for long in a 2-cycle cylinder.

It is apparently impossible that the development of the double-acting Diesel engine be mentioned without some statement or retort that there is difficulty in keeping the stuffing-boxes tight. Can it not be understood that if a piston can be packed in a cylinder, a connecting rod can be packed in a stuffing-box? There is no trouble with this detail, the experience obtained in double-acting gas-engine practice with cylinders up to 54 in. in diameter having in this regard proved applicable.

What then, it will be asked, is the bugbear of the double-acting engine development? So far as the 4-stroke cycle is concerned, one may state that steady and consistent progress has been made by at least one firm, viz., the M.A.N. branch at Augsburg, and I have been fully convinced that the users of these engines obtain full satisfaction. The upper stage of this advance is marked at present by 2000 h.p. on a single crank, but the proof of independent service is still lacking in the case of this power.

Four other firms to my knowledge have proceeded along this path without going further than the first experimental set. With the 2-cycle double-acting engine the case is wholly different. The stresses arising from the temperature-differences within the inner walls of the cylinder covers have so far proved insuperable obstacles. Fair progress had been made against these faults by more than one German firm, but those people still had far to go. There is this, however, to be said in favor of the 2-cycle double-acting engine that it does not suffer from the bearing troubles which are the bane of the 2-cycle single-acting engines.

Referring to the matter of crossheads, in Europe all Diesel engines of 500 h.p. designed for the propulsion of mercantile sea-going or ocean-going vessels have crossheads. In Russia some engines for Caspian Sea and River Volga service have been built without crossheads even in sets of 600 h.p. No submarine engines have them, although the U. S. Navy has encouraged the construction of a twin pair of powerful sets with crossheads. All double-acting engines naturally have them and at least two manufacturers have produced vertical single-acting land engines with this feature.

Regd. W. Crowley.

22 Madison St., Geneva, N. Y.

COMMENT ON ARTICLE LISTED IN ENGINEERING SURVEY

To the Editor:

On page 274 of The Journal for March, 1916, appears the following heading at the top of the page: Selected Titles of Important Engineering Articles, and the sixth one of these *selected titles* is "Air in Compression and Expansion, C. K. Bennett, Power, Feb. 8, 1916."

One wonders whether an engineer read this article before the selection was made, or whether it is the policy of the Editors of The Journal of the American Society of Mechanical Engineers to select Important Engineering Articles merely from the title without regard to contents. It would seem not altogether unreasonable to expect the official organ of the Society to select articles having real merit to place under such a heading.

In order to enable those who may not have seen the article by Mr. Bennett, to appreciate the viewpoint of the writer, the following discussion of it is offered.

The first statement in the article is: "In the compression of air all the work done is converted into heat and shows itself in the temperature of the compressed air." This is made as a general statement and as such it is entirely wrong regardless of the interpretation of the indefinite phrase, "in the compression of air." If this phrase refers only to that part of the stroke during which the pressure is being increased, but no delivery of air to the receiver is taking place, then it would be incorrect for all cases, except the adiabatic. If, on the other hand, the phrase was intended to include all the processes involved in the air compressor cycle, the statement becomes even worse. Thus imagine a compressor with such perfect cooling that isothermal compression may be attained; then such a compressor, once started, would run itself, if it be true, as the article states, that "all the work done shows itself in the temperature of the compressed air"!

Then follows a discussion of a chart which was intended to give the temperature and volume of air after compression according to the law $PV^n = \text{const.}$ One statement is: "The curves marked 1.41, 1.35 and 1.25 are plotted for the given exponents representing the ratio $c_p \div c_v = K$, and express the ratio of specific heat at constant pressure and constant volume." It will be news of considerable importance to most engineers to learn from this *selected article* that this ratio of specific heats of air, by some magical power perhaps, has suddenly acquired the property of changing its value to anything from 1.25 to 1.41!

Examining the chart itself one finds many more incorrect values than correct ones. Thus for the temperatures, the only curve which is even approximately correct is the one for which $n = 1.41$, the errors in the other curves in some cases amounting to 20 deg. fahr. or more.

On the right hand side of the chart appears a scale labeled: "Thousands of B.t.u. given up to the air per hour when compressing 100 cu. ft. of free air per min." This is an indefinite expression but *might* mean one of two things. First, it might be taken to mean the gain in intrinsic heat of the compressed air. Second, it might mean the net work in B.t.u. per hour required by an ideal compressor when handling 100 cu. ft. of free air per minute. It fails to do either, however, since the values given are about 40 per cent too high for the former and could be correct for the latter meaning only for the one curve in which $n = 1.41$. The author has evidently erroneously assumed that the net work of the compressor cycle is independent of the exponent, n. He has therefore apparently plotted the values on the right-hand side of the chart as though they depended on the temperature rise of the air alone.

The article closes with the statement: "the heat available for heating from the compressed-air transmission pipes can also be readily determined." It is implied that this information might be obtained from the chart, but the method is left to the reader's imagination.

F. O. Ellenwood.

Ithaca, N. Y.

[The articles listed in each issue at the conclusion of the Engineering Survey are selected with reference to their scope or originality, as judged by a cursory examination; and the Editor is glad to have comments upon them from any members who have had the opportunity to study the original articles more thoroughly.—Editor.]

NOTES

The Russian Ministry of Finance, through the Commercial Attaché to the Imperial Russian Embassies, 44 Whitehall Street, New York City, announces an extension till September 1, 1916, of the time for presenting for competition for prizes methods of utilizing alcohol for industrial purposes.

As a result of the great increase in the price of red prussiate of potash, extensively used as a coating material for blueprint paper, an economical method of preparing the substance has been devised by the U. S. Department of Agriculture. The Department has issued a circular describing the necessary apparatus, which has been developed primarily for use in the government service, but is equally available for other purposes.

Elaborate theories of multiple evaporators have been founded on the basis of equal temperature differences in each vessel, but it is well known that the temperature distribution corresponds much more closely to equal pressure differences, though no good explanation has been offered.

It has been suggested that the transmission depends on absolute temperature, on absolute pressure, on vapor density, etc., but none of these explanations carry conviction.

A new theory is that the explanation of the observed results is to be found in the kinetic theory of gases; the application of this theory to multiple evaporators at once gives results so closely in accordance with practice that there appears to be good reason for considering the application justified.—*The Engineer, February 18, 1916.*

The Department of Engineering of the Johns Hopkins University has organized a course in gas manufacture and byproduct recovery. This course involves essentially the study of the distillation of carbon and the utilization of all the products of the process. It deals with the principles underlying the gas industry and the production of most of the chemicals used in the industries of the world. The work is taken up in both lecture room and laboratory, for which special equipment is provided. Capt. Frederick H. Wagner, Mem.Am.Soc.M.E., chief engineer of The Bartlett Hayward Company, Baltimore, is delivering the course of lectures.

It is the intention of the Department of Engineering to publish monographs covering the work done and to distribute copies to those interested. The facilities of the laboratory will be available so far as possible for special research work in the gas industry, full reports of which will be published.

WORK OF THE BOILER CODE COMMITTEE

At a meeting of the Council of the Society in January 1916, the entire Boiler Code Committee was reappointed as constituted for the year 1915, to serve for another year. The inquiries which the Committee had been authorized by the Council to consider for the purpose of making interpretations, have been submitted to the Committee in increasing numbers as additional States have applied the Boiler Code for local regulation, and an organized effort was seen to be necessary to meet the requirements in this direction.

At the meeting of the Boiler Code Committee called in January, however, Mr. John A. Stevens tendered his resignation as chairman of the Committee, feeling, as he stated, that on account of his appointment to the Council as one of the Managers, the honor of chairmanship might properly be incumbent on some other member of the Committee. The resignation was tendered with the idea that there were other members of the Committee whose activity in the early work of formulating the Code entitled them to consideration for the position.

The resignation was considered by the Committee in session, Dr. Jacobus presiding in the absence of the Chairman, and as a result the following resolution was unanimously passed:

RESOLVED: that the members of the Boiler Code Committee, appreciating the untiring energy and service of Mr. Stevens in formulating the Boiler Code, request him to withdraw his resignation and remain Chairman of the Committee.
(Signed by all of the Members of the Committee.)

Mr. Stevens, when tendered this resolution, expressed his appreciation of this action and in withdrawing the resignation, he promised his best efforts in the Committee's future work.

Three meetings of the Committee have been held since the report published in the January issue of The Journal of the interpretations rendered in 1915, which included forty-three cases in all. Cases Nos. 47-58 have been considered by the Committee and replies formulated and approved by the Council of the Society; Case No. 45, which was reported in the January issue of The Journal as in the hands of the Committee, is now complete. In addition to the above cases that have been approved, Cases Nos. 59-66 are now under consideration by the Committee.

The procedure in the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed on at a regular meeting of the Committee. This interpretation is submitted to the Council for approval, after which it is issued to the party making the inquiry and later published in The Journal, in order that any one interested may readily secure the latest information concerning the interpretations.

In this issue are presented 12 interpretations rendered in Cases Nos. 45 and 47-58, with the exception of Case No. 49 which is in the hands of the Committee. In this report, as previously, the names of inquirers have been omitted.

Case No. 45

Inquiry: Pars. 19 and 20 of the Code require a minimum thickness of $\frac{1}{4}$ in. for shells and $\frac{3}{8}$ in. for heads; are these thicknesses necessary in small vertical tubular boilers of a type built for laundry purposes to work at pressures from 15 to 100 lb., which are 10 in. in diameter by 36 in. long and contain seven $1\frac{3}{4}$ in. tubes 30 in. long? Would shells formed of 10 in. lap welded standard boiler tubing 0.202 in. thick which has been tested to 500 lb. pressure be acceptable?

Reply: The thickness and material for the shell of this boiler does not comply with the Code requirements. In order for such construction to be stamped with the Code symbol it would be necessary for the material to be of such quality as called for by the Code, and other details to comply with the requirements as set forth.

Case No. 47

Inquiry: An opinion is requested as to whether a particular design of pressed steel lugs for horizontal return tubular boilers, which are of dimensions shown in catalogue, are made in accordance with the Boiler Code? Par. 323 does not specify the dimensions required on lugs for boilers up to 78 in. in diameter.

Reply: All such lugs must be large enough to permit of using the number and size of rivets required by Par. 325 and where the boilers are over 78 in. in diameter they must meet the requirements as to dimensions called for by Par. 323.

Case No. 48

Inquiry: Is or is not a bushing required on the feed connection where it enters any type of boiler. Is a bushing required where the blow-off connection is threaded directly through the dished head of a boiler drum, and if so, how many pipe sizes larger than the normal diameter of the pipe must it be. If a flange is riveted to the head is a bushing required?

Reply: The boiler bushing or equivalent is obligatory only where both external and internal pipes making a continuous passage are used. The brass or steel bushings referred to in Paragraphs 307, page 76, and 315, page 77, are provided for the purpose of making the external and internal pipes absolutely separate with definite clearance between their ends so that the removal of either will not disturb the other; a properly designed flanged construction which will effect this will comply with the intention of the Committee. See also Rule 300, page 76, and Table 7, page 68.

Case No. 49

(In the hands of the Committee.)

Case No. 50

Inquiry: It is recommended that in the steel tube specifications in the Boiler Code that the flange test be not required for tubes over 5 in. diameter, that tubes over 6 in. diameter should be tested to 500 lb. per sq. in., and that in gaging the tubes as to size, the measurements should be made, according to the usual custom, near the ends of the tubes, the variation in diameter of tubes over 4 in. not to exceed $\frac{1}{2}$ of 1 per cent either way.

Reply: The tube specifications in the Boiler Code were prepared at a joint conference of the tube makers and were adopted by the Boiler Code Committee in precisely the way they were presented. It can, therefore, be seen that should any amplifications be made it is no more than fair that all affected interests be consulted. No changes can be made in the Code except at a revision period at which all interested parties may be heard, which will probably be deferred until near the limit of the two years specified in the Code. The Committee, however, renders interpretations for features not covered explicitly by the Code, and would gladly consider suggestions from the boiler tube manufacturers who prepared the specifications now in the Code.

CASE No. 51

Inquiry: Please explain the application of Par. 182, 182-*a*, and 182-*b*, to rivet lay-outs for quadruple butt strap joints.

Reply: Par. 182 of the Boiler Code fully describes the rivet lay-outs for quadruple butt strap joints. To explain in detail, rivet lay-outs are shown in Fig. 5 to indicate its application. The "back pitch," which is the distance A between center lines of any two adjacent rows of rivets measured at right angles to the direction of the joint, must be not less than twice the rivet diameter (Par. 182). In details like B, Par. 182-*a* is applicable, which specifies that the sum of the two diagonal sections of the plate between the inner rivet and the two outer rivets must be at least 20 per cent greater than the section of the plate between the two rivets in the outer row; that is, $a + b$ must be at least 20 per cent greater than c. In details such as C, Par. 182-*b* is applicable, which specifies that the sum of the two diagonal sections of the plate between the two inner rivets and the two rivets in the outer row shall be at least 20 per cent greater than the difference in the section of the plate between the two rivets in the outer row and the two rivets in the inner row; that is, $e + f$ must be at least 20 per cent greater than $g - d$.

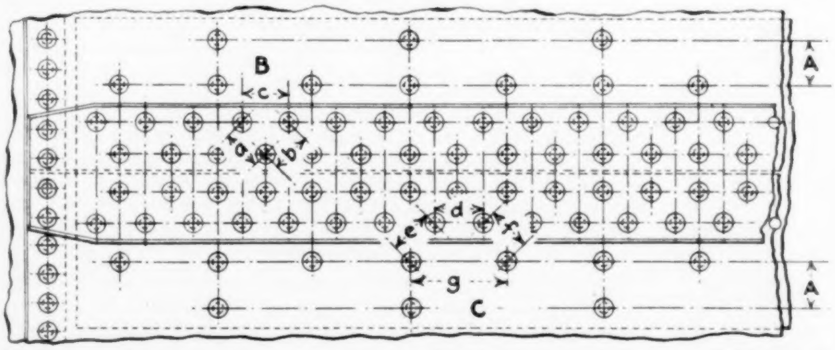

FIG. 5 A TYPICAL QUADRUPLE BUTT STRAP JOINT, SHOWING APPLICATION OF PAR. 182

CASE No. 52

Inquiry: Why was the factor of safety of 5 adopted for stationary boilers, while the Interstate Commerce Commission has established the minimum factor of safety of 4 for locomotive boilers, and there have no doubt been many boilers in operation at lower factors of safety without any trouble?

Reply: The factor of safety of 5 was selected for stationary boilers for the reason that all types of such boilers under all variations of efficiency of maintenance had to be covered with one factor of safety. Rules for locomotive boilers, not subject to Federal inspection, may be formulated later and added to the Boiler Code rules, which are not intended to cover locomotive boilers subject to Federal inspection.

CASE No. 53

Inquiry: Par. 21 seems to work an injustice to manufacturers of water tube boilers who are using 3 in. tubes, as for this size one gage heavier than standard is required.

Reply: The gages of tubes to be used have been specifically mentioned on page 10 of the Boiler Code, edition of 1914 with Index.

CASE No. 54

Inquiry: Please state the authority for the requirements in Par. 195 that "dished heads with the pressure on the convex side shall have a maximum allowable working pressure equal to 60 per cent of that for heads of the same dimensions with the pressure on the concave side," and give the formula on which it is based.

Reply: The rules on dished heads referred to were adopted after investigation of the general practice on the subject, and practically agrees with other standards. It was found that all rules in use are empirical and not theoretical, the latter being too complicated for general use.

CASE No. 55

Inquiry: In ordering a new boiler stamp to replace one that is worn out, is it necessary to submit a new affidavit to the Boiler Code Committee?

Reply: When a user of the A.S.M.E. boiler stamp returns a wornout stamp, a new one may be issued in its place, at the usual price, without requiring the filing of a new affidavit.

CASE No. 56

Inquiry: An opinion is desired as to whether a particular make of automatic water gage conforms to the interpretation given in Case No. 35.

Reply: The Committee has decided that it will not express opinions on types of boilers or of apparatus and it will therefore be impossible to comply with the request for an opinion. If there is anything ambiguous in the reply to Case No. 35, the Committee will gladly answer any inquiry respecting same.

CASE No. 57

Inquiry: Ordinary shop practice does not seem to be covered by the Code. For instance, Par. 239 applies only to furnaces of $^5/_{16}$ in. plate or thicker; in actual practice, however, furnaces 20 to 40 in. in diameter are built of $\frac{1}{4}$ in. plate, more or less staybolted.

Reply: The furnace of a vertical fire-tube boiler need not be stayed if the maximum allowable working pressure computed by Par. 239 of the Code is equal to or in excess of the pressure under which the boiler is to be operated. If the pressure computed by Par. 239 is less than that at which the boiler is to be operated, the furnace should be fully stayed in accordance with the rules for flat surfaces. Furnace sheets should in all cases be $^5/_{16}$ in. thick or over.

CASE No. 58

Inquiry: Please advise as to what the Committee proposes to do about correcting the rule limiting pressure on malleable iron to 160 lb. so as to permit a proper pressure on malleable iron junction boxes?

Reply: Attention is called to Par. 9 on page 8 of the Boiler Code, which reads as follows:

> 9. Cross pipes connecting the steam and water drums of water tube boilers, headers and cross boxes and all pressure parts of the boiler proper over 2 in. pipe size, or equivalent cross sectional area, shall be of wrought steel, or cast steel or class B grade, as designated in the Specifications for steel castings, when the maximum allowable working pressure exceeds 160 lb. per sq. in.

This rule was adopted after the matter had been given very careful consideration by the Committee and after an extended conference had been held with the boiler using and boiler manufacturing interests.

SOCIETY AFFAIRS

THE SPRING MEETING AT NEW ORLEANS

IT has been said that one of the most important functions of a society is the offering of the right of association, and such association makes for a sense of distinction and of pride. The member of a society feels that in cities which are strange to him he has yet the right to fellowship with other members there so far as the right may be wisely exercised, and in turn he is stimulated to do his own share as he is bound by an *esprit de corps* to confer benefits upon his associates similar to those he has himself received.

It is very gratifying that there is at the present time a spirit of association pervading the whole membership of the Society. The Local Sections are strengthening their bonds with the Society proper and with one another, as are also the Student Branches.

In the preliminary work for the Spring Meeting, the Committee on Meetings in New York has experienced the closest coöperation with the Committee on Arrangements in New Orleans, and there is no question but what the good-fellowship spirit will permeate the whole meeting, and that members and guests will take with them to their homes an impression of

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VIEW IN CITY PARK, NEW ORLEANS

the hospitality of our Southern friends which will stimulate them to return to their fellow-member hosts, by contributing in increased measure to the activities of the Society, benefits of equal value to those they receive.

Full particulars of the New Orleans meeting, April 11 to 14, were given in the last issue of The Journal, in an article which included the program of the meeting, transportation arrangements, hotels, social features, etc. It only remains therefore to list the papers to be presented and discussed, which are as follows:

Wednesday morning, April 12

ORGANIZING FOR INDUSTRIAL PREPAREDNESS, Spencer Miller, Member of Council, Am.Soc.M.E., Member Naval Consulting Board.

Thursday morning, April 13

CAPACITY AND ECONOMY OF MULTIPLE EVAPORATORS, E. W. Kerr, Mem.Am.Soc.M.E.

THE EVOLUTION OF LOW LIFT PUMPING PLANTS IN THE GULF COAST COUNTRY, William B. Gregory, Mem.Am.Soc.M.E.

MECHANICAL EQUIPMENT USED IN THE PORT OF NEW ORLEANS, William von Phul, Mem.Am.Soc.M.E.

Friday morning, April 14

ESTABLISHING A STANDARD OF MEASUREMENT FOR NATURAL GAS IN LARGE QUANTITIES, Francis P. Fisher, Mem.Am.Soc.M.E.

DEVIATION OF NATURAL GAS FROM BOYLE'S LAW, Robert F. Earhart and Samuel S. Wyer, Mem.Am.Soc.M.E.

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SOME EXPERIMENTS ON WATER-FLOW THROUGH PIPE ORIFICES, Horace Judd, Mem.Am.Soc.M.E.

THE MEASUREMENT OF VISCOSITY AND A NEW FORM OF VISCOSIMETER, H. C. Hayes and G. W. Lewis.

DYNAMIC BALANCE, N. W. Akimoff.

DISASTROUS EXPERIENCES WITH LARGE CENTER-CRANK SHAFTS, Louis Illmer, Mem.Am.Soc.M.E. (Contributed by the Gas Power Committee.)

ON THE TRANSMISSION OF HEAT IN BOILERS, E. R. Hedrick and E. A. Fessenden, Mem.Am.Soc.M.E.

The topic of the first of these papers is timely, and it is expected that the paper will call forth some interesting discussion.

Three of the papers are "Southern" papers—dealing with engineering problems peculiar to the sugar and rice industries of the South.

The remaining papers cover a wide field, and include results of highly important experiments and developments in their respective subjects.

Abstracts of the papers are included below in order that members may obtain an idea of their purport, and request

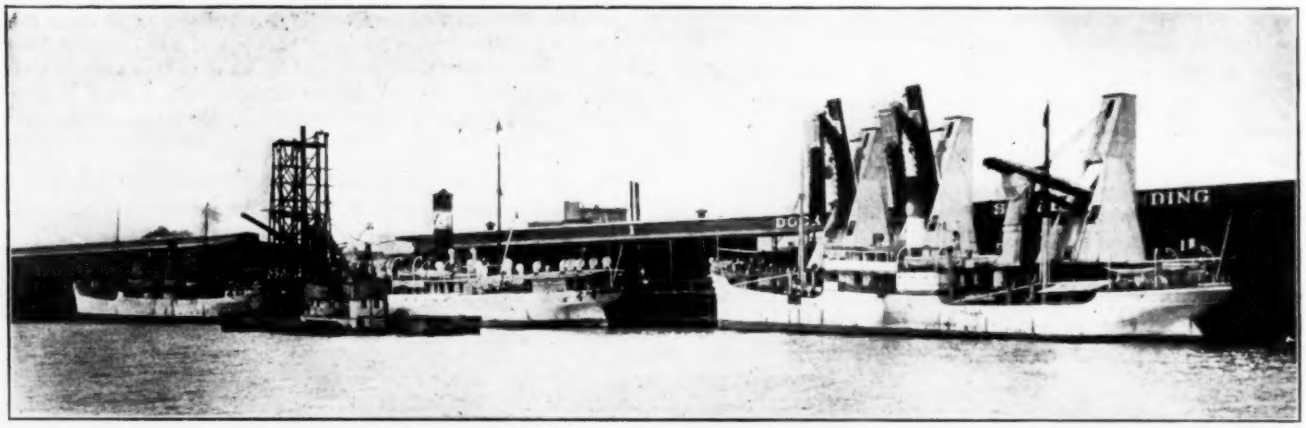
copies of the papers for contributing discussion if they have not already done so.

THE STOP AT BIRMINGHAM

A unique entertainment will be provided by the Birmingham Local Section for those who stop over at Birmingham on the way to New Orleans. The program that has been arranged is as follows: The guests will assemble at the Tutwiler Hotel at 9 a.m., and from there proceed to the Louisville & Nashville depot where they will board a special train for a trip around the district. This train will stop first at the Republic Iron & Steel Company's furnaces at Thomas, and then at the Ensley blast furnaces, open hearths and mills of the Tennessee Coal, Iron & Railroad Company. From there it will proceed to Bayview where a view of the impounding dam may be had and where a Barbecue will be served. Leaving here the party will stop at the Edgewater Mine of the T. C. I. & R. R. Co., and will next visit the by-product coke plant and the works of the American Steel & Wire Company, and from there return to Birmingham. The party will finally be taken through the Manufacturers Exhibit Building. At about 6:45 p.m. a dinner will be served in the banquet hall of the Tutwiler Hotel for the nominal price of $1.50 per plate, which it is hoped that the visiting members will arrange to attend in order to become better acquainted with the local members in Birmingham. The dinner will be entirely informal and evening dress is not expected.

PAPERS FOR THE SPRING MEETING

In this issue the complete list of the papers for the Spring Meeting is given in the program and abstracts follow below of all but that by William von Phul, on Mechanical Equipment Used in the Port of New Orleans, which it is expected will be received in time for the meeting. These papers are of a high order of merit and are miscellaneous in character, treating of a variety of subjects. All of these papers are being printed in pamphlet form for distribution in advance of the meeting and copies of any or all of them will be sent gratis to members applying *to the Secretary* prior to the meeting. After the meeting extended abstracts of the papers and an account of the proceedings, with discussion, will appear in The Journal so that members will have early information concerning the events of the meeting. Finally, the papers, together with the discussion, will be printed in complete form in the annual volume of Transactions for 1916 for permanent reference.



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SHIPPING SCENE ON THE RIVER FRONT, NEW ORLEANS

ORGANIZING FOR INDUSTRIAL PREPAREDNESS

BY SPENCER MILLER

The engineer is active nowadays in army and navy affairs, as witnessed by the appointment of the Naval Consulting Board, the nomination of representatives for the Industrial Census, the movement for an Engineer Reserve Corps and the notable lectures on Military Engineering which are being given to the engineers of New York and vicinity.

In recognition of this trend in the engineering profession, the author raises the question for discussion of how the engineer may best serve his country as a result of the call by the government for coöperation in organizing for preparedness, a movement which is obviously very largely dependent on engineering.

The first step in this direction was the invitation from Secretary Daniels of the U. S. Navy, to The American Society of Mechanical Engineers and ten other organizations, to form a U. S. Naval Consulting Board to be headed by Thomas A. Edison, Hon.Mem.Am.Soc.M.E. This board resolved itself into committees, one of which, the Committee on Production, has as its Chairman Howard E. Coffin, Mem.Am.Soc.M.E.,

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BONZANO HOUSE, JACKSON'S HEADQUARTERS, CHALMETTE, NEAR NEW ORLEANS

who formulated a plan for organizing the industries for preparedness. This led the President of the United States to invite this Society and four others to nominate a representative in each state to assist the Naval Consulting Board in "collecting data for use in organizing the manufacturing resources of the country for the public service in the case of emergency." Its immediate work will be to make an inventory of the facts necessary to be known to the army and navy relating to the resources of the nation for the supply of munitions of war in case of need.

The author shows that with the facts of this census properly collated we shall learn where we are weak and where strong. Not only will it be known where munitions, which include supplies of all kinds, can be obtained, but how rapidly they can be produced; to what extent America is independent of foreign countries for raw materials and manufactured products; for what kinds of munitions we have ample manufacturing facilities, and wherein we must provide means for making up the deficiency.

These and other questions are suggested by the author and it is hoped that by way of discussion the membership will present other aspects of the situation which will have a helpful bearing on the problem of how the engineer may best serve his country.

Among the topics which suggest themselves are the following:

How can mechanical engineers consolidate their efforts in a way to oversee effectively the manufacture of munitions?

Should there be modification of standards for arms and ammunition to facilitate their manufacture?

What part should tools, gages, jigs and machine tools play in Industrial Preparedness?

What part should the textile schools take in the training of men for responsible positions in munitions manufacture, and in the testing of materials?

What should be done in the way of storing materials—nitrate and tungsten, for example—against a time of need?

Inasmuch as this paper is to be presented at the New Orleans meeting, there are certain questions relating to southern industry which may profitably be discussed. The resources of the South might supply the country with many materials needed during a period of curtailment of commerce with other nations. For example, products, and especially by-products, to be derived in manufactures of wood; in the production of sugar, cotton oil and molasses; and in the petroleum and chemical industries, especially with reference to crude oil, gasoline and sulphur.

CAPACITY AND ECONOMY OF MULTIPLE EVAPORATORS

By E. W. Kerr

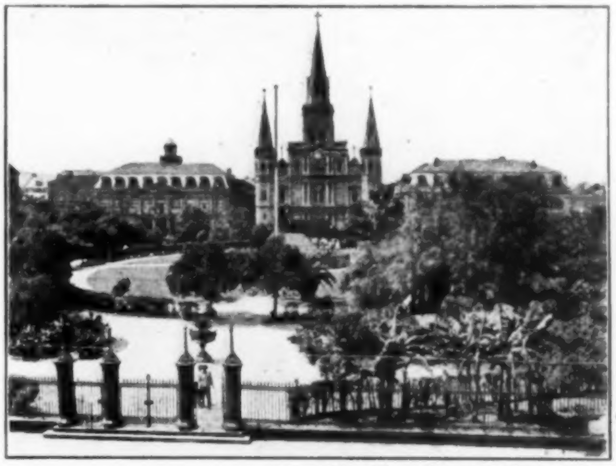
In 1913, the author presented a paper before the Society entitled "Tests upon the Transmission of Heat in Vacuum Evaporators," giving the results of a series of experiments upon laboratory apparatus at the Louisiana State University. The present paper gives the results of further experiments on the laboratory apparatus, though the larger portion of the paper is devoted to the results of 38 tests made on full-sized evaporators in sugar factories. The evaporators tested included the following types:

A Vertical submerged tube (so-called standard)
B Horizontal steam tube
C Horizontal film
D Vertical film
E Vertical submerged tube with special baffles in calandria for distributing steam (vacuum)
F Vertical submerged tube with special baffles in calandria for distributing steam (atmospheric)
G Vertical steam tube with vent pipe for each tube (double tube)

and among these were double, triple and quadruple effect apparatus.

Preceding the results of the experiments a general discussion of the factors affecting heat transmission in evaporators as compared with surface condensers is given.

The tests showed a great variation in the coefficient of heat transmission, not only for different types, but in different evaporators of a given type. This variation was due to difference of design and operation, including steam velocity and density, method of venting, cleanliness of heating surface on both steam and juice sides, velocity of liquor circulation, density and purity of liquor and height of boiling.



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Jackson Square and the Cathedral, New Orleans

The coefficients of heat transmission in the factory evaporators were, as a rule, lower than those obtained with the laboratory apparatus and higher than is usually obtained with surface condensers. The average coefficients obtained in the tests of different types were as follows, the coefficient for type A being taken as 100:

A	100
B	108
C	199
D	135
E	126
F	255
G	149

These, however, cannot be taken as an absolute measure of the heat transmitting capacity per unit of heating surface in the different types, because conditions were not equally favorable in all cases.

In thirteen of the tests, the steam condensed in the first body was determined and from this and other data, the thermal efficiency has been calculated. The thermal efficiency varied from 85 to 97.5 per cent. The variation was due to difference in the radiation losses and vent losses. The radiation loss varied with the capacity of the evaporators, the number of bodies, the proportion of external surfaces covered and the difference between the temperature of the steam inside and the atmosphere outside.

The paper includes illustrations of the types tested, also tabulated data relative to heat transmission and economy. From the tests, curves are presented showing the coefficients

of heat transmission found in each of the different types plotted against steam pressure or vacuum.

THE EVOLUTION OF LOW-LIFT PUMPING PLANTS IN THE GULF COAST COUNTRY

BY W. B. GREGORY

It is the object of this paper to show the part that pumping machinery has had in the development of the City of New Orleans and in the reclamation of the fertile wet prairie lands of Louisiana and Texas; also to show the importance of pumping plants to the rice industry of the Southwest. To this end the history of pumping in this section is briefly related and examples of typical pumping plants are given.

About ten years ago a movement was started by Edward Wisner to reclaim the wet prairie lands lying at or near Gulf level. The work is now being carried out on an extensive scale. More than a quarter of a million acres of agricultural lands have been reclaimed or are at present in the process of reclamation in the state of Louisiana. The land reclamation has been of such recent development that there is no adequate record of the magnitude of the pumping plants, such as was furnished by the Special Censors of 1910 for irrigation, and this the paper aims to furnish.

In this section it was only natural and normal that pumps used successfully in drainage work would be employed in the irrigation of rice when that industry developed. Often the lift for irrigation did not exceed that in common use in drainage plants and especially in relift irrigation pumping plants. Drainage by pumps was an accomplished fact before the irrigation of rice assumed proportions that made the industry of economic importance. Later on drainage received a fresh impetus from the reclamation of the wet prairie land while the rice industries had obtained maturity. The story of pumping plants in this section therefore deals at times with drainage and at times with irrigation.

ESTABLISHING A STANDARD OF MEASUREMENT FOR NATURAL GAS IN LARGE QUANTITIES

BY FRANCIS P. FISHER

Some three years ago the author became associated with the reorganized management of a natural gas pumping system in the Mid-Continent field. In the course of investigations preparatory to outlining a general policy, there was discovered between purchase and sales a loss of gas which seemed wholly unreasonable. The total loss could be made up from leakage in field lines, leakage in main lines, leakage in distribution systems, errors in large capacity meters, errors in domestic meters and errors in estimates of unmeasured gas.

The first step in eliminating this waste in various parts of the system was to provide an accurate gas measurement at strategical points. Manifestly the first problem was that of large capacity meter installation, and with part of the losses possibly due to meter inaccuracy, the first step was establishing a definite standard of accuracy in meters.

A catalogue of the weaknesses and objections to all known and available methods was formulated, and is given in the paper. It was determined that the relative objections be weighed and one of the systems chosen as a standard to be developed to a closer degree of accuracy than heretofore available. The method chosen for development was the orifice meter, in the belief that the objections to the existing types could be overcome at less cost and more simply than to any of the others.

The work done to establish a standard has been continued for approximately two and one-half years; it has now passed the second phase of installing measuring stations to segregate and locate definitely the remaining leakage losses.

There is no question but what any of the other methods of measurement than the orifice meter is capable of an equal degree of refinement, but the present paper is chiefly concerned with the work actually done on this type of meter.

DEVIATION OF NATURAL GAS FROM BOYLE'S LAW

BY ROBERT F. EARHART and SAMUEL S. WYER

In this paper the magnitude of the natural gas compressing and measuring problem, and known data regarding probable deviation of natural gas from Boyle's law, are summarized.

Tests were made by the authors in the laboratory of the Department of Physics, Ohio State University, Columbus, Ohio, on eight representative natural gas samples from various parts of the United States, to ascertain by accurate volumetric measurement whether or not these natural gases did deviate from Boyle's law, and if so, under what conditions. The apparatus used and methods followed are illustrated and described in detail. The data obtained are given in tabulated and graphical form.

These data shows conclusively:

That all of the observed deviations of natural gas from Boyle's law are in one direction—in favor of the buying company where gas is measured under high pressure conditions

That the different gases have marked peculiarities and marked differences of deviation

That there is no direct relationship between the deviation and ethane content

That the direct application of Boyle's law to high pressure natural gas measuring problems gives only an exceedingly rough approximation.

EXPERIMENTS ON WATER FLOW THROUGH PIPE ORIFICES

BY HORACE JUDD

During the past ten years papers upon the flow of fluids have appeared from time to time in the Transactions of the Society; most of these have dealt with the flow of air and gas, although a few have treated of the flow of steam, and the methods set forth have for the most part centered around the venturi meter and the pitot tube. During this period, also, many forms of meters have been brought out for the measurement of air, gas and steam, as well as of water, all more or less successful in operation, and of these, also, a great many have made use of the principles of the venturi meter or the pitot tube.

The pipe orifice has not hitherto met with much favor for the measurement of the flow of steam or water in a pipe, although it is coming into use for air and gas measurement and has been used with certain types of steam meters of German make and also in Bailey flow meters. The chief objections to the pipe orifice have seemed to be that a special form of orifice flange was needed and that considerable uncertainty prevailed concerning the pressure conditions adjacent to the orifice, so that the working coefficients for an orifice in a pipe were not so reliable as those of the venturi meter or the pitot tube.

About two years ago, while employing the Bailey meter to measure the steam used by an engine, the writer became in-

terested in the orifice as a pipe-flow measuring device. It was important to know at what point near the orifice the attachment should be made in order to measure correctly the pressure drop of the steam flowing through the orifice, and it was thought that an investigation would reveal many valuable points concerning the flow conditions through the orifice in a pipe. The present line of work is the final outcome of this thought and has been carried on in connection with water flow, since water could be more easily handled than steam, the intention being to continue later with a study of the flow conditions in a steam line.

The paper is really a record of progress, for only a few points are touched upon, such as the pressure changes in the vicinity of the diaphragm, or orifice; the probable location of the least section, or zone of greatest velocity, of the water jet; and the working coefficients of the diaphragms; leaving many other points of equal interest and importance to be studied into later. The experiments were confined to one size of water pipe (5-in.) and the pressure drop through the diaphragm did not run much in excess of 6 ft. of water, which was considered to be the probable maximum drop desirable to use in connection with any automatic registering device. For the largest diaphragm this range of pressure drop gave an average velocity of 17.5 ft. per sec.

THE MEASUREMENT OF VISCOSITY AND A NEW FORM OF VISCOSIMETER

By H. C. Hayes and Geo. W. Lewis

This paper deals with the measurement of viscosity. It predicts the errors which are introduced by the various types of viscosimeters and verifies these predictions in case of the short capillary types such as the Saybolt, Engler, and Redwood and the orifice types such as the Carpenter, by comparing the temperature vs. viscosity curve for a light and a medium lubricating oil, as given by these meters, with the true curves as determined by a modified form of Poiseuille's capillary tube method.

The work shows that the short capillary types give results about 50 per cent too small and the orifice types give results about 100 per cent too small, and further, none of these meters give accurate comparative results for two different oils or for the same oil at different temperatures.

The only type of viscosimeter on the market that can be expected to give accurate results on theoretical grounds is the Stormer. This instrument attempts to measure the viscosity in terms of the torque required to spin a disk within the liquid, but the mechanical difficulties met with are such as to debar this type.

The authors have designed and thoroughly tested out a viscosimeter which embodies all the good points of the Stormer and none of its defects. They measure the viscosity in terms of the torque which a cylinder experiences when suspended within a rotating liquid. This method eliminates all error due to friction. The results given by this meter agree with the true curves for the light and medium oils to within 1 per cent and can safely be used as a standard.

The advantages of this viscosimeter are evident. The instrument can be calibrated to give direct readings of the viscosity; the oil is not handled during a complete test at various temperatures; the design of the instrument is such that the temperature of the specimen follows closely the temperature of the bath, so the data for the temperature vs. viscosity curve can be taken while the sample is cooling; the meter gives the viscosity of mixtures, such as paints, as well as for liquids that have been carefully filtered; there are no glass parts to break; the personal error is eliminated and the meter can be made self recording.

DYNAMIC BALANCE

By N. W. Akimoff

Dynamic balance is a part of mechanics of engineering and not merely a shop method. The problem is perfectly capable of a definite solution if proposed in a rational manner and treated along rational lines. The importance of running balance in high speed machinery is well understood. The author separates the problem into two parts, static and dynamic balance, and explains dynamic unbalance by the so-called centrifugal couple.

He describes his machine for creating a centrifugal couple at will, which may be adjusted by trial to exactly counteract the one that may be present in the body to be tested. This additional couple is created in the machine by means of a so-called squirrel cage, which at the same time permits of definitely establishing the plane and the sign, and of estimating the exact numerical value of the centrifugal couple of the body.

Applications of these principles to actual practice of balancing, together with explanation of working methods and remarks as to what does and what does not come under the problem of dynamic balance, are made in the paper.

DISASTROUS EXPERIENCES WITH LARGE CENTER-CRANK SHAFTS

By Louis Illmer

This paper is descriptive of some disastrous experiences with large gas engine shafts of the center-crank type. Investigations as to the cause of the repeated shaft failures, revealed inherent structural weakness. The reënforcements undertaken to remedy this condition were based upon a careful stress analysis of actual sag determinations conducted upon the wheel shaft.

The shafts in question were mounted in three-point bearing supports and carried a very heavy flywheel between the intermediate and outboard bearings. The diagrams show that this mode of support sets up a pernicious interaction of bearing load, which culminates in excessive wear in the intermediate bearing.

When the wheel shaft lacks adequate stiffness, the appreciable lift of the free end of the web portion of the shaft exerts a pressure against the cap of the outer main bearing, which in turn causes the intermediate journal to become overloaded. The drop resulting from rapid wear reduces the upward thrust against the outer main bearing cap and this finally relieves the intermediate bearing of overload. Still further wear causes a portion of the downward shaft load to be transferred from the intermediate bearing to the outer main bearing.

It was found that when this readjustment is complete, the load upon the two main bearings becomes approximately equalized. The attainment of this state of equilibrium as to wear, involves putting an excess stress upon the shaft fibers, which is likely to lead to ultimate breakdown of the wheel shaft.

The observed wear in the intermediate bearings was found to exceed $\frac{1}{8}$ in. in less than thirty days of operation when starting with newly aligned bearings, but after the intermediate bearing had dropped sufficiently to equalize the load

upon the two main bearings, the wear became more nearly normal.

The stress curves corresponding to the actual shaft deflection curves show the critical surface fibers to be subjected to a reversing stress ranging from 16,000 lb. per sq. in. compression to more than 29,000 lb. per sq. in. tension stress.

The life of these shafts, as expressed in observed running time required for breakdown service, appears to be in accord with the expected number of revolutions as determined by Stromeyer's Law of Fatigue.

The character of the reënforcements that were necessary to strengthen the shaft design, is outlined and the resulting improvements in stress and sag relations are recorded in the diagrams. In making replacements, both carbon and nickel steel forgings were tried out, but the nickel steel shafts did not come up to expectations.

Specification details and acceptance tests are also tabulated and the results of tests bars taken from some critical sections of the defective nickel steel shaft are compared with somewhat similar tests made upon a carbon steel shaft. These tests point to elongation as being the vital factor in shaft specifications.

The working stresses which broke the defective nickel steel shaft are analyzed and the proper proportions for web design are discussed. When carrying a heavy wheel, the web dimensions should be made heavier than usual so as to allow for the increased span between the wheel supports, which invariably results from excess wear in the intermediate main bearing.

In order to keep the wheel shaft stress within desired limits under load conditions found in these engines, it became necessary finally to enlarge the intermediate journal to 3/2 of its original diameter, thus making its dimensions fully as large as would be required for side crank construction.

The conclusion arrived at is, that for large stationary gas or oil engines, it is advisable to use the side crank construction rather than a center-crank shaft, since the former type eliminates the troubles encountered when carrying a heavily loaded wheel shaft upon a three-point bearing support.

Appendix I briefly outlines the method used in arriving at the sinuous deflection curves resulting when a wheel shaft is mounted in three aligned bearing supports. Appendix II prescribes the safe stress limits for shaft design and defines the shock allowance suitable for varying engine speeds. The rate at which shafts may be expected to deteriorate from fatigue when subjected to excess stress is also discussed.

The aim of the paper is to call attention to the importance of making careful analysis of the underlying stress conditions, before fixing upon the final dimensions for a center-crank shaft carrying heavy flywheels. The method advocated provides against wheel shaft failure and admits foretelling whether or not a given crank shaft has a sufficiently large net factor of safety to withstand a heavy wheel load without ultimate breakdown.

ON THE TRANSMISSION OF HEAT IN BOILERS

By E. R. Hedrick and E. A. Fessenden

The authors have found difficulty in checking the results of experiments quoted in the literature with the theories commonly proposed for the transmission of heat from the hot gases to the water in the boiler. In particular the formulae given by Sir John Perry and others appear not to check with the data given by various writers.

In working over this matter the authors have been led to an assumption which seems particularly reasonable in view of the fact that the resistance to heat transfer almost certainly changes with the temperature on account of the dependence of the resistance on the behavior of the film of gas next to the pipe and of the film of water next to the pipe, rather than on the material of the pipe itself. The authors were led to make the assumption that the quantity of heat lost by a given small weight of gas falls off as the gas passes down the pipe in accordance with the ordinary damping law usual in physical phenomena. After working with this hypothesis for some time and finding that it agreed with the data better than the formulae usually given, the authors have found that an equivalent assumption of simple character can be stated in terms of the difference in entropy of the gas at the temperature of the gas and of the gas at the temperature of the water. The assumption is that the rate of change of this difference is proportional to this difference, where the rate is taken with respect to the actual distance down the tube.

The theoretical consequences of such an assumption are worked out in some detail, and they are brought to the point where graphical check with numerical data is easily possible. The actual comparisons with the theory of Sir John Perry and with that of this paper are shown by a number of graphical figures so arranged that the points should lie on straight lines in each case in case the corresponding theory is correct. It is found that the agreement is quite a little better with the theory of this paper than with that of Perry. The data used are the old French experiments, a set of experiments furnished by Wm. Kent, several sets of experiments conducted by the Pennsylvania Railroad, and a large series of tests conducted at the University of Missouri by Prof. E. A. Fessenden.

COUNCIL NOTES

At the meeting of the Council on March 10, 1916, the following members were present: D. S. Jacobus, *President*, John H. Barr, R. M. Dixon, *Chairman Finance Committee*, A. M. Greene, Jr., W. B. Jackson, C. T. Main, H. de B. Parsons, John A. Stevens, E. H. Whitlock, Wm. H. Wiley, *Treasurer*, and Calvin W. Rice, *Secretary*.

The President announced the appointment of the following Nominating Committee as the result of the coöperation of the Local Sections with him: H. M. Montgomery, *Chicago;* E. H. Ohle, *St. Louis;* Walter B. Snow, *Boston;* D. Robert Yarnall, *Philadelphia;* J. T. Whittlesey, *San Francisco*.

Interpretations of the Boiler Code Committee, Nos. 47-58, were approved and ordered published; they appear elsewhere in this number of The Journal. On the announcement by the Committee of the retirement of its Secretary, Mr. C. W. Obert, to become Secretary of the American Society of Heating and Ventilating Engineers, it was voted to concur in the following resolution of the Committee:

"The Boiler Code Committee of the American Society of Mechanical Engineers having been informed of the retirement of their Secretary, Mr. C. W. Obert, take the opportunity this day, by resolution in executive session, of thanking Mr. Obert for his faithful and untiring devotion and assistance in the work of formulating and promulgating the A.S.M.E. Standard Code, as well as his untiring efforts in behalf of the Code and Committee in the past.

"We, the members of the Boiler Code Committee, sincerely regret the loss of his efficient services, and trust that Mr. Obert will meet with the full measure of success in his new position which he deserves."

Messrs. Olof Ohlson, B. M. W. Hanson, Carl A. V. Carlsson, Gustave Fast, Bruno V. Nordberg, Erik Oberg, Harold P. Norton, C. von Philp, Alfred H. Raynal and H. A. Gillis were appointed to represent the Society in Washington and appear in favor of a Memorial to John Ericsson. A report appears elsewhere in The Journal.

It was voted to approve a resolution from the Pan American Engineering Committee, composed of appointees from the four national engineering societies, to make this committee a permanent committee to promote greater engineering and scientific intercourse and the welfare of the engineering profession of South and Central America and the United States.

Calvin W. Rice, *Secretary.*

C. W. OBERT SECRETARY OF HEATING AND VENTILATING ENGINEERS

Mr. C. W. Obert, for the past three years Associate Editor of the Society's publications, has accepted an invitation by the Council of the American Society of Heating and Ventilating Engineers to become the Secretary of that organization, with headquarters in the Engineering Societies Building, New York. He will take up his new duties at once.

Mr. Obert's connection with the office of The American Society of Mechanical Engineers began when the Boiler Code Committee had completed the first draft of its report, which led to his being drawn into the service of the Committee during the long and arduous period of meetings and conferences which preceded the issuance of the report in its revised and completed form. In February 1915, when the Advisory Committee was added to the membership of the Boiler Code Committee, he was made a member of the enlarged committee, and its Secretary, and it is hoped that he may find it possible to continue in this capacity. Appreciation of his untiring efforts and a sincere desire for his success in his new undertaking have been fittingly expressed by resolutions of the Committee, in which the Council of the Society was pleased to concur.

Besides his editorial position with this Society, Mr. Obert has previously acted in an editorial capacity on other publications, including The Engineering Record, when it was devoted largely to heating and ventilating subjects, which gave him an acquaintance with engineers in this field, and a familiarity with their work, admirably equipping him for his new position.

The American Society of Heating and Ventilating Engineers is progressing rapidly, three new chapters in Cleveland, Detroit and Philadelphia respectively having been organized, and should constitute a favorable field for the abilities of its new Secretary, to whom all good wishes are extended by his many friends and former associates in The American Society of Mechanical Engineers.

CONFERENCE ON ABBREVIATIONS AND TERMINOLOGY

In line with efforts that are being made by a number of organizations to standardize engineering abbreviations and terminology, a conference was recently held by the Committee on Electrical Measurements, Values and Terminology of the National Electric Light Association, for the purpose of definitely starting the movement and putting on record such terms as could be unquestionably agreed upon. The conference which was held in the Engineering Societies' Building in New York, on March 9, was attended by representatives of the editorial departments of The American Institute of Electric Engineers, The American Institute of Mining Engineers, The American Institute of Wiring Engineers, The American Society of Mechanical Engineers, The American Society of Heating and Ventilating Engineers, and The Iluminating Engineering Society. The chairman of the Committee of The National Electric Light Association is Dr. A. E. Kennelly.

The conference was devoted largely to a study and analysis of the abbreviations employed by the various engineering societies for terms in common use and of the practice of these societies with reference to the use of compound words. Careful study was made of the abbreviations in general use, and complete agreement was reached concerning the abbreviations given in the list below. All abbreviations upon which unanimous agreement could not be had were omitted from consideration.

Name	Abbreviation
Alternating current	a.c., when used as a compound adjective; spell out in other cases.
Ampere	amp., or spell out.
Boiler horse power	boiler h. p.
Brake horse power	b.h.p.
British thermal units	B.t.u.
Candle power	c.p.
Centigrade	cent. (c. in tabular matter)
Centimeters	cm.
Circular mils	cir. mils (c. m. in tabular matter)
Counter electromotive force	counter e. m. f. (c. e. m. f. frequently used)
Cubic	cu.
Diameter	spell out
Direct current	d. c. when used as a compound adjective; spell out in other cases
Electric horse power	e.h.p.
Electromotive force	e.m.f.
Fahrenheit	fahr.
Feet	ft.
foot pounds	ft. lb.
Gallons	gal.
Grains	gr.
Grams	g.
Gram calories	g. cal.
High-pressure cylinder	spell out
Hours	hr.
Inches	in.
Indicated horse power	i.h.p.
Kilogram	kg.
Kilogram meters	kg. m.
Kilogram calories	kg. cal.
Kilometers	km.
Kilowatts	kw.
Kilowatt hours	kw.hr (kwh. frequently used)
Linear	lin.
Liter	l.
Magnetomotive force	m.m.f.
Mean effective pressure	spell out
Millimeters	mm
Milligrams	mg.
Minutes	min.
Meters	m.
Meter kilograms	m. kg.
Ohms	spell out
Per	spell out
Per cent	spell out (or % in tabular matter)
Pounds	lb.

Power factor	spell out
Revolutions per minute	rev. per min. (r. p. m. frequently used)
Seconds	sec.
Square	sq.
Square root of mean square	r. m. s.
Ton mile	spell out
Tons	spell out
Volts	spell out
Volt amperes	spell out
Watts	spell out
Watt hours	watt hr.
Watts per candle	spell out (w. p. c. frequently used)
Yards	yd.

NOTE: In certain kinds of technical work the periods following the abbreviations are omitted where ambiguity is impossible.

1. Use "Fig.", not "Figure." Example: "Fig. 3" and not "Figure 3."
2. In all decimal numbers having no units, a cipher should be placed before the decimal point. Example: "0.32 lb."; not ".32 lb."
3. Use the word "by" instead of "x" in giving dimensions. Example: "8 by 12 in." not "8 x 12 in."
4. Never use the characters (′) and (″) to indicate either feet and inches or minutes and seconds as periods of time.
5. When two or more words are compounded as a noun they should be written as separate words with space or spaces between or as a single word without the hyphen.
6. The hyphen should be employed mainly in compound words used adjectively.

HOW TO ORGANIZE A SECTION

The Committee on Sections is anxious to extend the benefits of the Society as rapidly and as far as possible. Obviously the initiative must be taken by the members themselves and in those centers where the numbers and interest are sufficient to warrant meetings being undertaken. In the places where Sections are now established, those participating in the work find it interesting and beneficial, and much good has resulted to the individual members as well as to the Society.

A Section of the Society may and preferably should coöperate with and help build up the local engineering organizations by the holding of joint meetings, and invite all members of such organizations and all engineers generally to its meetings. This phase of Section work has been especially well developed at St. Louis and Philadelphia.

The Society through the Committee on Sections is anxious to assist the membership in the organizing and developing of Sections both by appropriation to cover fixed expenses and by practical advice, such as suggesting names of prominent engineers to make technical addresses and also arouse enthusiasm.

Birmingham, Ala., with eighteen members, is the last place to form a Section. By including those members within a radius of sixty miles the membership of this section is brought up to about twenty-eight. At the March meeting there was an attendance of sixty-five per cent and much enthusiasm shown. All are united in making preparations for the reception of members attending the Spring Meeting. The Birmingham Section has invited all members and guests of the Society to visit their city on Monday, April 10, and have arranged an elaborate program.

There are numerous cities where the strength of the Society is as great as it is at Birmingham and it is suggested that some member arrange a meeting in all places where there are twenty or more members and discuss the question of organizing a Section. A pleasant way of holding such a meeting is to get together informally at luncheon or supper. Such a movement can be started with little effort and almost no expense. As it usually works out in this world that one gets out of a thing in proportion to what he contributes to it, those taking the initiative are usually well repaid for their public spriit.

JOINT MEETING OF STUDENT BRANCHES

SITUATED NEAR THE CITY OF NEW YORK

An innovation in Student Branch activities will be held at the Engineering Societies Building on Friday evening, April 14, when the four Student Branches of the Society located within the Metropolitan District of New York will hold a joint meeting followed by a smoker in the rooms of the Society. The Branches taking part in this affair are those at Columbia University, New York University, Polytechnic Institute of Brooklyn and Stevens Institute of Technology. A prominent speaker will make an address, followed by an illustrated technical paper of general interest. Following this there will be a smoker and good fellowship meeting, so that all may have the opportunity of increasing their acquaintance among their future colleagues.

All members of Student Branches resident outside New York, visiting New York at the time of this meeting, are invited to attend.

The Committee in charge of arrangements is L. H. Nielson (Columbia University), *Chairman*, C. A. Pines (New York University), Herman Brandt (Polytechnic Institute of Brooklyn) and J. M. Wilcox (Stevens Institute).

GREETING THE NEW COMER

At the last meeting of the Committee on Sections the following resolution was adopted:

"VOTED to advise the Chairman of each Section that the Committee on Sections and the Council have approved placing on the mailing lists of Sections the address of every graduate member of a Student Branch who shall locate within the territory of any Section and that the Secretary of the Section may expect to receive additions from time to time as these students graduate and locate in the vicinity of the Section.

"Such notification will automatically enroll the graduated member of a Student Branch as a member of the Section in which he locates. Allowance will be made in making the annual appropriation for each Section for each graduate student member so enrolled."

Responses have already been received from a number of the Chairmen of Sections and of Student Branches expressing the opinion that this will prove of great assistance to the young engineer. It should also benefit the Society by encouraging undergraduates in colleges where no Student Branch now exists to petition the Council for the establishment of Student Branches.

There are now forty Student Branches and these are doing an excellent work as will be seen by a perusal of the pages of The Journal devoted to a description of Student Branch activities. About fifteen hundred students are enrolled in the membership of these Branches, more than half that number subscribe to The Journal, and later about one-fifth become members of the Society.

The above procedure of maintaining the hold on men whose interest we have once obtained is obvious.

LECTURES ON MILITARY ENGINEERING

The success of the military engineering lectures given in New York under the auspices of the officers of the national engineering societies by officers of the U. S. Army provided by Major General Wood has exceeded the most sanguine expectations.

Over 3000 men are attending the lectures every Monday in the Engineering Societies Building and the building of the American Society of Civil Engineers respectively.

In response to requests for advice as to literature on the subjects of the lectures, the following textbooks have been secured. These constitute a special course of reading for engineers in civil life who desire to inform themselves on military subjects:

Infantry Drill Regulations, 1911. Can be obtained from the Superintendent of Documents, Washington, D. C. Price about 60 cents. (Govt. Printing Office.)

Field Service Regulations, 1914. Can be obtained from the Superintendent of Documents, Washington, D. C. Price 60 cents. (Govt. Printing Office.)

Notes on Field Fortification, Army Field Engineer School. Can be obtained from Book Dept., Army Service Schools, Ft. Leavenworth, Kansas. Price 30 cents.

Engineer Field Manual. Can be obtained from Superintendent of Documents, Washington, D. C. Price $1.00. (Govt. Printing Office.)

Military Topography for Mobile Forces, Sherrill, 2nd Edition. Banta Publishing Co., Menasha, Wis. Price $2.25.

Studies in Minor Tactics, Army Service Schools, 1915. Can be obtained from Book Dept., Army Service Schools, Ft. Leavenworth, Kansas. Price 50 cents.

The Service of Coast Artillery, Hines and Ward. Goodenough & Woglom Co., 122 Nassau Street, New York City. Price $3.50.

A free circular issued from the office of the Chief of Engineers, War Department, Washington, D. C., gives a complete bibliography of the subject of military engineering. From this the above titles have been selected.

JOSEPH A. HOLMES MEMORIAL

The Joseph A. Holmes Safety Association, formed to perpetuate the memory and work of the first director of the bureau of mines, who died last July, was formally established by old associates on March 3.

It was agreed that the association shall each year make awards with honorariums to those who perfect the most efficient safety devices in the mining, quarrying and metallurgical industries, these awards to be known as the Holmes awards. It was also agreed that the heroism of miners shall be rewarded.

Suitable medals are to be given to those who distinguish themselves at mine disasters in saving life and to those whose services in directing the work at mine disasters are conspicuous. The association will meet once each year in Washington, when the awards and medals will be publicly announced. The next meeting will be held March 1, 1917.

A campaign to raise an endowment fund will be started as soon as the permanent secretary is selected. The officers elected were: Van H. Manning, director of the bureau of mines, president; Dr. Charles D. Walcott, secretary of the Smithsonian Institution, first vice president; Samuel Gompers, president American Federation of Labor, second vice president. These officers also constitute the executive committee, with the addition of Hennen Jennings, Washington, and Dr. John A. Brashear, Past-President of our Society.

NAVAL CONSULTING BOARD

At the meeting of the Naval Consulting Board held in the Engineering Societies Building on March 8, the main topic of discussion was the securing for this country of an adequate supply of nitrogen products, vital to the military and agricultural interests of the country. The members discussed the creation of a synthetic plant for the fixation of nitrogen from the air, the laying in of a store of nitrogen sufficient to last through the first year of any war, and the investigation of possible nitrate fields in the United States.

Spencer Miller, Member of the Council, and W. L. R. Emmet, the Society's two representatives on the Board, were present.

ERICSSON MONUMENT

Capt. John Ericsson, a former member of this Society and one of the greatest engineering geniuses of the nineteenth century, was proposed as an Honorary Member of the Society at its formation in 1880, but he declined to be so ranked, preferring to be considered as still among those bearing the burdens of active practice. His friends in the Society desired in 1886 to give him a testimonial banquet in recognition of his marvelous talent, but he would not hear of it, even when solicited by his most intimate friends. He died in 1889, but all through the years following, the effect of his epoch-making inventions, notable among them the screw propeller, has been cumulative, making it fitting that the American nation, the prosperity of greatness of which has been largely achieved through engineering, should erect a perpetual memorial to his name.

A bill has now been introduced in Congress for the consummation of this plan, and the mechanical engineering profession at large and the Society in particular will look upon its passage as the expression of the country's desire to pay full tribute to one of its greatest representatives. A hearing of this bill was held in Washington on March 13, at which Messrs. Erik Oberg, C. A. V. Carllson, Gust Fast, H. A. Gillis, O. Ohlson, C. von Philp and A. H. Raynal, representing the Society, were present. Our thanks are due these gentlemen for their efforts to attend this hearing and for their service in our interest.

The Society possesses some unique memorabilia of Captain Ericsson, which are on exhibition in the Engineering Societies Building and which it will repay all members visiting the Society's rooms to see. Among these are:

An oil portrait executed by the artist Ballin and believed to be the only portrait painted of him.

A bust in plaster, presented by the late James M. Dodge, Past-President of the Society, together with a reproduction of it in bronze.

A most valuable set of models, with ease, to illustrate his inventions and experiments in connection with his work on the hot air engine, the solar motor, and other products of his inventive capacity. This set was originally prepared for and exhibited at the Centennial Exhibition. It was presented by Captain Ericsson's executors to the Metropolitan Museum of Art in New York, which in turn presented it to the Society.

Further, there is in the library a monumental work written and published by Captain Ericsson himself in 1876, entitled Contributions to the Centennial Exhibition, a statement of his principal labors and an account of his philosophical instruments, engines and other structures.

UNITED ENGINEERING SOCIETY

REPORT OF TREASURER

To the Board of Trustees,
United Engineering Society.

I respectfully submit the following report of your Treasurer for the year ending December 31st, 1915.

FINANCES

Due to the growth of the activities of the United Engineering Society, it was found desirable early in the year to consolidate the various accounts and financial records of the Society and of the Library, heretofore kept separately, and to have all the data pertaining to the building and its operation in the charge of one individual. An assistant secretary especially assigned to this work has been appointed, and a separate office has been established. The Finance Committee has had all of the records brought fully to date and has prepared a new set of account books to meet the new conditions.

The Real Estate Account now includes the following items:

Land	$ 540,000.00
Building	1,050,000.00
Equipment	33,171.16
Founder Societies, Preliminary expenses	24,000.00
Total	$1,647,171.16

The principal of the mortgage on the land held by Andrew Carnegie, amounting originally to $540,000, has been finally satisfied in full by payments from the Land and Building Funds of the Founder Societies. These payments were $5000 from the American Institute of Mining Engineers in January and $54,000 from the American Institute of Electrical Engineers in June.

The gross operating expenses for the year 1915 were $44,440.28, an increase of $4858.64 over the gross expenses of the preceding year. This increase was due chiefly to the unusual alterations on the sixth floor, amounting to $4258.36. The total revenue for the year was $48,028.20.

The funds available for the uses of the Library Board during the year were $17,444.87. The expenditures of the Library Board were $16,415.14, leaving an unexpended balance of $1029.73.

The General Reserve Fund of $10,000 created by the Board of Trustees at a meeting held November 19th, 1914, to be available to take care of unforeseen fluctuations of income and outlay, has been preserved intact, there arising no calls on this fund during the year 1915.

At the beginning of the year 1915 the amount of Contingency and Renewal Fund was $51,441.39. To this amount has been added the sum of $2404.28 for interest earned by the investments for this fund during the year, and $5000 added from surplus at the end of the year, bringing the total at the end of the year to $58,845.67.

The following summary shows the reserve accounts and the investments therefor:

Depreciation and Renewal Fund	$51,441.39
Add: Interest on Invested Funds during Year 1915	2,404.28
Transfer for the Year 1915	5,000.00
	$58,845.67
General Reserve Fund	10,000.00
Engineering Foundation Fund	200,000.00
Library Endowment Fund	5,000.00
	$273,845.67

The Astor Trust Company of New York is the official custodian of the securities of the United Engineering Society.

During the year the Finance Committee with the assistance of experts has revised the assessments for space occupied by all Societies, Founders as well as Associates. In doing this, consideration has been given to location as well as area occupied, and the system of assessment made uniform. The schedule of rates is available for examination by any interested person or society.

GIFTS AND ENDOWMENTS

On January 27, 1915, Mr. Ambrose Swasey presented to the United Engineering Society the sum of $200,000 in securities, the income only therefrom to be used for the purposes of the Engineering Foundation, for "the advance of the engineering profession and the benefit of mankind."

On April 5, 1915, Dr. James Douglas presented the sum of $5000 to the United Engineering Society to form the nucleus of an Endowment Fund for the Library.

BUILDING

Meetings or Lectures. The record of the number of times the rooms were used during the year 1915 for meetings or lectures (not for office occupancy) is:

Meeting Room		Number of Times Occupied 1914	1915	Change
1st floor Foyer		0	1	1 more
Auditorium	3rd and 4th floors	76	42	34 less
No. 1 Assembly Room	5th floor	58	53	5 less
2 Assembly Room	5th floor	94	76	18 less
3 Assembly Room	5th floor	46	49	3 more
5 Assembly Room	6th floor	0	2	2 more
Small Committee Room on	1st floor	18	34	16 more
Assembly Room 1201 on	12th floor	53	30	23 less
Total		345	287	58 less

LIBRARY

During the year the administration of the Library has been made the subject of an agreement executed by the three Founder Societies and the United Engineering Society under which all expenses of the Library are paid from the United Engineering Society office. Each Founder Society has contributed $4000 and the remainder of $2500 has been paid by the United Engineering Society. The total appropriation for books and administration amounted to $14,500 for the year. In addition there were derived from searches, $2410.80, and from sales and income, $534.07, making a total revenue of $17,444.87.

In June there was effected a consolidation of the various insurance policies heretofore held separately by the Founder Societies and the United Engineering Society, into one policy covering all.

Full details as to the Library are shown in the annual report of the Library Board. (See The Journal, February, 1916.)

Respectfully submitted,
(*Signed*) Jos. Struthers, *Treasurer*.

UNITED ENGINEERING SOCIETY

Assets and Liabilities, December 31, 1915

ASSETS

Real Estate	$1,647,171.16
Investments—Engineering Foundation Fund	200,000.00
Library Endowment Fund	5,002.50
General Funds	58,138.75
Cash	11,307.05
Unexpired Insurance	3,949.16
Accounts receivable	3,785.36
	$1,929,353.98

LIABILITIES

Founders Equity in Property	$1,647,171.16
Due the General Reserve Fund	10,000.00
Due the Depreciation and Renewal Fund	58,845.67
Due the Engineering Foundation Fund	200,000.00
Due the Library Endowment Fund	5,000.00
Due the Library Board, 1915, Unexpended balance	1,029.73
Surplus, December 31, 1915	7,307.42
	$1,929,353.98

Certified by
Barrow, Wade, Guthrie & Co.

Correct
Chas. F. Rand
Jesse M. Smith
H. H. Barnes
Finance Committee.

NOTES

The Case School Student Branch has arranged to visit the Engineering Societies Building on April 4. The party will be in charge of Prof. F. H. Vose.

The Engineering School of Pennsylvania State College, in charge of Prof. Hugo Diemer, Professor of Industrial Engineering, will visit the Building on April 17.

Prof. Joseph W. Roe and about 75 members of the Senior Class of Yale University will visit the headquarters of the Society on Thursday, April 13, while in New York on their Annual Inspection Trip. An invitation has been extended to them to be the guests of the four metropolitan Student Branches of the Society who will hold a joint meeting that evening at the Engineering Societies Building.

The Institute of Metals has reconstituted its Corrosion Committee. This committee exists primarily to investigate the question of the corrosion of brass condenser tubes, though at a later date the corrosion of other metals (except iron and steel) may be subjected to inquiry.

The final report of the Director of Congresses of the Panama-Pacific International Exposition shows that 928 congresses and conventions were held in or near San Francisco from February 20 to December 4, 1915. This establishes a new world's record for conventions.

The American Academy of Political and Social Science announces its twentieth annual meeting on April 28 and 29. The meeting will be held in Philadelphia and will partake of the nature of a national conference on the general topic, "What America Stands for in International Relations," and a discussion of the most important political, social, economic and financial problems which have been forced on this country by the abnormal conditions abroad. The President of the Academy is Dr. L. S. Rowe, University of Pennsylvania.

Changes in the conditions governing the use of gas for domestic purposes have caused the New York Public Service Commission to consider altering the method of testing it, on the grounds that modern appliances require that gas should have a heating value only, and that the present candle-power standard was a hindrance to distribution without corresponding advantages, in that it increased the cost because of the rising price of the enriching oils that had to be added, and the present standards were wasteful and burdensome both to the consumers and to the companies.

The Cleveland Engineering Society, which has secured a reputation for unique publicity methods, is planning to issue a special publication sometime during the current year designed to acquaint the intelligent public with the work of the engineer and the manner in which it is performed, in the hope that a more intimate knowledge of this subject will increase and improve the opportunities for engineering activity, and facilitate the proper and efficient execution of engineering projects. The society solicits suggestions concerning the design of the publication or the manner of handling its physical make-up.

The following letter to the Secretary from a member of the Council who was asked to endeavor to ascertain why a certain member of the Society living near him had sent in his resignation, indicates the splendid work our Chairmen of Sections are doing in greeting members who are strangers but who wear the Society's pin:

Dear Mr. Rice:

Your letter of March 4 regarding Mr. .... came duly to hand.

I have just returned from a call on Mr. .... in company with Mr. ...., Chairman of the Local Section, and found that Mr. .... was already prepared to withdraw his letter sending in his resignation on account of a rather interesting coincidence.

Mr. .... happened to be a guest at the Club one noon. The Chairman of the Section noted his A.S.M.E. pin and introduced himself with the remark that he was glad to meet him but believed he had never seen him at any of our local meetings. Mr. .... promptly replied that he had not been at any of the meetings and that he had sent in his resignation to the Society. The Chairman remarked that he felt he ought not to resign, especially in the light of the excellent local meetings that we are having.

I telephoned Mr. .... this noon and said that I would like to call on him and talk about The American Society of Mechanical Engineers. He told me that he had sent in his resignation but would be glad to talk with me as he was rather inclined to reconsider his action, since he had met a gentleman at the Club who had told him something about the local activities of the Society. I then suggested that the Chairman and I would like to call on him toegther, and he said that he would be glad to talk to us.

He informed us that he would send his check for dues right along.

Mr. .... is a fine fellow and it would have been a serious loss to the Society to have lost him from its membership roll.

I have written you so fully regarding this matter more particularly so that you will have so fine a concrete example in mind of what a well conducted Local Section of the Society means to our membership, since in this case the activities of the Local Section have brought back to us of his own volition a splendid member, who under other conditions would have been brought back only after most strenuous urging and explanations, if at all. I am personally confident that this can be considered as a good indication of what we can expect from the activities of our Local Sections along one line and that there are many other directions in which we may expect the Local Sections to strengthen the Society with equally marked effectiveness.

Cordially yours,

....

APPLICATIONS FOR MEMBERSHIP

TO BE VOTED ON MAY 10, 1916

Members are requested to scrutinize with care the following list of candidates who have filed applications for membership in the Society. These are subdivided according to the grades for which their ages qualify them and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third class under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into Membership by advising the Secretary promptly of any one whose eligibility for membership is in any way questioned. All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote. Unless objection is made by some member by May 10, 1916, and providing satisfactory replies have been received from the required number of references, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary about June 15, 1916.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

ALLINGHAM, HENRY W., Cons. Prod. Engr., British Govt., Nortendon, Cheshire, England
ANTONSANTI, LOUIS, Contr. Engr., Ponce, P. R.
BREAKER, HARRY O., Mgr. Economizer Dept., B. F. Sturtevant Co., Boston, Mass.
BRINER, EMIL A., East. Rep., New York Blower Co., E. Orange, N. J.
BROWNE, GAIL H., Asst. Engr., Ford, Bacon & Davis, New Orleans, La.
CARY, ARTHUR F., Supt. of Trade School, Mass. Reformatory, Concord Junction, Mass.
COLE, WILLIAM E., Supt., Connecticut Elec. Mfg. Co., Bridgeport, Conn.
CONN, CHARLES F., Mgr., San Francisco Office, J. G. White Engrg. Corp., San Francisco, Cal.
FERGUSON, WILLIAM B., Prod. Engr., Remington Arms & Ammunition Co., Bridgeport, Conn.
GAETJE, JOHN H., Mech. Engr., Western Elec. Co., Hawthorne, Ill.
HAUSLER, HARRY F., Ch. Draftsman, Amer. Sugar Refining Co. of N. Y., Brooklyn, N. Y.
HENDERSON, JOSEPH W., Bureau Ch., Bureau of Smoke Regulation, City of Pittsburgh, Pa.
HOLMES, OTIS W., Prop., O. W. Holmes Co., Boston, Mass.
KELLER, ALFRED R., Draftsman, The Morgan Constr. Co., Worcester, Mass.
LUCAS, CHESTER L., Associate Editor, "Machinery," New York
MCMUNN, WILLIAM N., Contr. Engr., Private Business, Chicago, Ill.
MACDONALD, HOWARD D., Supt. Experiments, Tractor Wks., Internatl. Harvester Corp., Chicago, Ill.
MEAHL, PHILIP J., Inventor, Summit, N. J.
REESE, OLIVER P., Asst. Engr. Motive Pwr., Penna. Lines West of Pittsburgh, Pittsburgh, Pa.
SALISBURY, ROBERT W., Mech. Engr., Texas & Pacific Ry., Marshall, Tex.
SHREVE, EARL O., Mgr. Apparatus Dept., Genl. Elec. Co., San Francisco, Cal.
SIMON, JOSEPH J., Cons. Lubrication Engineer, The Texas Co., New York
SMITH, PHILIP C., Supt. Fdy. Dept., Ingersoll-Rand Co., Phillipsburg, N. J.
STANGLAND, ROBERT S., Operating Engr., W. S. Bartow & Co., Inc., New York
STANSFIELD, WILLIAM T., Genl. Insptr., Globe Indemnity Co., New York
THOMPSON, RALPH C., Supt., Cutting Tool Supply, Remington Arms Co. of Del., Eddystone, Pa.
WEBRE, ALFRED L., Engr., J. H. Murphy Iron Wks., New Orleans, La.
WEST, RALPH H., Pres. and Genl. Mgr., West Steel Casting Co., Cleveland, Ohio
WILLIAMS, LEWIS E., Ch. Draftsman, Dredging Div., The Panama Canal, Off. of Res. Engr., Paraiso, C. Z.
WOOLFOLK, WILLIAM G., Mgr., Chicago Office, Sanderson & Porter, Chicago, Ill.

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

FERGUSON, CHRISTIAN W., Asst. Supt., Outside Erecting Dept., Henry R. Worthington, Harrison, N. J.
GAW, FREDERICK W., with Babcock & Wilcox Co., Bayonne, N. J.
HAMILTON, DOUGLASS T., Assoc. Editor, "Machinery," New York
HAMMOND, JOHN H., JR., Inventor, Gloucester, Mass.
HARLOW, ARCHIBALD S., Dept. Head, Bosch Magneto Co., Springfield, Mass.
HAYNES, CLAUDE P., Prod. Engr., Curtiss Aeroplane & Motor Corp., Buffalo, N. Y.
HORTHY, WILLIAM A., Mech. Engr., Tractor Wks., Internatl. Harvester Co., Chicago, Ill.
LEWIS, ALEXANDER T., Mem. Firm, Lewis, Robinson & Gant, Engrs., Philadelphia, Pa.
LUNDGREN, FREDERICK G., Mech. Engr., Amer. Car & Fdy. Co., Terre Haute, Ind.
MAYER, LEO, Constr. Engr., Otis Elevator Co., Cleveland, Ohio
POLLOCK, ROBERT T., with New England Westinghouse Co., Springfield, Mass.
ROWE, HAROLD E., Asst. Wks. Engr., The Carborundum Co., Niagara Falls, N. Y.
SHUSTER, MYER M., with Remington Arms Co., Eddystone, Pa.
WIESE, OSCAR H., Draftsman and Checker, McIntosh & Seymour Corp., Auburn, N. Y.

FOR CONSIDERATION AS JUNIOR

BARRY, J. JOSEPH, Asst. Supt., Internatl. Trade Exch., Inc., Boston, Mass.
BEARD, JAMES T., JR., Dist. Mgr., Combustion Engrg. Corp., Cincinnati, Ohio
BROWN, HAROLD A., Overseer of Planning, Winchester Repeating Arms Co., New Haven, Conn.
BRUBACK, THEODORE M., Asst. Engr., Vulcan Soot Cleaner Co., Du Bois, Pa.
CORBETT, WILLIAM B., Mech. Designer, Terry Steam Turbine Co., Hartford, Conn.
EASTMAN, ROBERT L., Tech. App., Aultman & Taylor Mchy. Co., Mansfield, Ohio
FAULKNER, FRED L., Exper. Engrg. Dept., Western Elec. Co., Chicago, Ill.
HUNT, CHARLES W., Asst. Estimator for C. W. Hunt Co., Inc., W. New Brighton, N. Y.
KASPER, WALTER F., Mech. Engr., Fairmont Gas Eng. & Rwy. Motor Car Co., Fairmont, Minn.
KUHLEN, FREDERICK, JR., Safety Engr., Globe Indemnity Co., New York

Lassiter, Robert R.,
with The Texas Co., New York

Le Vally, John R., Engr.,
Burrell Belting Co., Chicago, Ill.

Marshall, William A., with Mech. Dept.,
Jones & Laughlin Steel Co., Woodlawn, Pa.

Maxfield, Lewis S., Draftsman, Motive Pwr. Dept.,
Interborough Rapid Transit Co. and New York Rwys. Co., New York

Mayer, James L., Mech. Draftsman.
Mark Mfg. Co., Zanesville, Ohio

Metcalf, George R., Jr., Lab. Asst.,
Engrg. Dept., Yale Univ., New Haven, Conn.

Miller, Clarence A., Student Grad.,
Yale Univ., Franklin, Pa.

Pearce, Clinton E., Instr. in Mch. Design,
Mech. Engrg. Dept., Lafayette College, Easton, Pa.

Riggs, George, Asst. in Mch. Design,
Yale Univ., New Haven, Conn.

Ritter, Ralph B., Valve Engr.,
Detroit Lubricator Co., Detroit, Mich.

Sampter, Herbert C.,
322 West 76th St., New York

Smith, Lloyd G., Asst. Foreman, Boiler Shop,
Standard Oil Co., Whiting, Ind.

Swinney, Stuart L.,
with The Texas Company, Port Arthur, Tex.

Tehle, Charles J., Student App.,
Aultman & Taylor Mchy. Co., Mansfield, Ohio

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Breckenridge, Clarence E., Asst. Ch. Engr.,
Aetna Explosives Co., Inc., New York

Christie, Alex. G., Assoc. Prof. Mech. Engrg.,
Johns Hopkins Univ., Baltimore, Md.

Taylor, Cecil H., Cons. Engr.,
Taylor & Neuteboom, Detroit, Mich.

PROMOTION FROM ASSOCIATE-MEMBER

Henderson, Herbert, Constr. Engr.,
Gulf Refining Co., Port Arthur, Tex.

Staniar, William, Mech. Engr.,
E. I. du Pont de Nemours & Co., Wilmington, Del.

PROMOTION FROM JUNIOR

Barnes, Arthur F., Dean of Engrg.,
New Mex. College of A. & M. E., State College, N. Mex.

Hagy, James L., Instr. in Mech. Draft. and Mch. Design,
Philadelphia Trades School, Philadelphia, Pa.

Honywill, Albert W., Jr., Engr.,
Terry Steam Turbine Co., Hartford, Conn.

Otto, Henry S., Cons. Engr., and Treas.,
Albert T. Otto & Sons, Special Mchy., Importers and Exporters, New York

Polledo, Ysidoro Y., Cons. Practice, Havana, Cuba

Reed, Chester T., Secy.,
Reed & Prince Mfg. Co., Worcester, Mass.

Van Cleve, Horatio P., Ch. Draftsman,
Harrington, Howard & Ash, Cons. Engrs., Kansas City, Mo.

SUMMARY

New applications	68
Applications for change of grading:	
Promotion from Associate	3
Promotion from Associate-Member	2
Promotion from Junior	7
Total	80

SUMMARY SHOWING AVERAGE AGE AND POSITIONS OF APPLICANTS ON BALLOT CLOSING APRIL 8, 1916

Average age of applicants:	
Members	45
Associates	35
Associate-Members	31
Juniors	24
Positions held by applicants:	
Executives, including Presidents, Vice-Presidents, Treasurers, Directors, Members of Firms, General Managers	8
Professors, Associate-Professors, Instructors	5
General Superintendents, Superintendents, Assistant Superintendents, Mechanical Superintendents	14
Consulting, Contracting and Constructing Engineers	3
Chief Engineers, Assistant Chief Engineers	6
Mechanical Engineers, Engineers, Assistant Engineers	15
Chief Draftsmen, Assistant Chief Draftsmen, Designing Engineers, Estimators	12
Managers, Assistant Managers, Sales Managers, Sales Engineers	3
Other classifications	12
Total	78

GEOGRAPHICAL INDEX

(Applications for promotion from any grade will be indicated by the initials of that grade)

California
San Francisco—Conn, C. F.
Shreve, E. O.

Canal Zone
Paraiso—Williams, L. E.

Connecticut
Bridgeport—Cole, W. E.
Ferguson, W. B.
Hartford—Corbett, W. B.
Honywill, A. W., Jr. (J.)
New Haven—Brown, H. A.
Metcalf, G. R., Jr.
Riggs, Geo.

Cuba
Havana—Polledo, Y. (J.)

Delaware
Wilmington—Staniar, W. (A.M.)

England
Nortendon—Allingham, H. W.

Illinois
Chicago—Faulkner, F. L.
Horthy, W. A.
Le Vally, J. R.
McMunn, W. N.
MacDonald, H. D.
Woolfolk, W. G.
Hawthorne—Gaetje, J. H.

Indiana
Terre Haute—Lundgren, F. G.
Whiting—Smith, L. G.

Louisiana
New Orleans—Browne, G. H.
Webre, A. L.

Maryland
Baltimore—Christie, A. G. (A.)

Massachusetts
Boston—Barry, J. J.
Breaker, H. O.
Holmes, O. W.
Concord Junction—Cary, A. F.
Gloucester—Hammond, J. H., Jr.
Springfield—Harlow, A. S.
Pollock, R. T.
Worcester—Keller, A. R.
Reed, C. T. (J.)

Michigan
Detroit—Ritter, R. B.
Taylor, C. H. (A.)

Minnesota
Fairmont—Kasper, W. F.

Missouri
Kansas City—Van Cleve, H. P. (J.)

New Jersey
Bayonne—Gaw, F. W.
E. Orange—Briner, E. A.
Harrison—Ferguson, C. W.
Phillipsburg—Smith, P. C.
Summit—Meahl, P. J.

New Mexico
State College—Barnes, A. F. (J.)

New York
Auburn—Wiese, O. H.
Brooklyn—Hausler, H. F.
Buffalo—Haynes, C. P.
Niagara Falls—Rowe, H. E.
New York—Breckenridge, C. E. (A.)
Hamilton, D. T.
Kuhlen, F., Jr.
Lassiter, R. R.
Lucas, C. S.
Maxfield, L. S.
Otto, H. S. (J.)
Sampter, H. C.
Simon, J. J.
Stangland, R. S.
Stansfield, W. T.
W. New Brighton—Hunt, C. W.

Ohio
Cincinnati—Beard, J. T., Jr.
Cleveland—Mayer, Leo
West, R. H.
Mansfield—Eastman, R. L.
Tehle, C. J.
Zanesville—Mayer, J. L.

Pennsylvania
Du Bois—Bruback, T. M.
Eddystone—Shuster, M. M.
Thompson, R. C.
Franklin—Miller, C. A.
Lafayette College—Pearce, C. E.
Philadelphia—Hagy, J. L. (J.)
Lewis, A. T.
Pittsburgh—Henderson, J. W.
Reese, O. P.
Woodlawn—Marshall, W. A.

Porto Rico
Ponce—Antonsanti, L.

Texas
Marshall—Salisbury, R. W.
Port Arthur—Henderson, H. (A.M)
Swinney, S. L.

PERSONALS

THIS department is intended for items about members of the Society, their professional work and incidents concerning them which may be of interest to the membership in general. Items are solicited upon important engineering developments in which members have been associated, and also newspaper clippings or manuscripts of addresses delivered by members at meetings of any kind are desired. It is hoped that every member of the Society will furnish an interesting item occasionally for publication in the Journal.

William H. Burleigh has become affiliated with the Burleigh Engineering Company of Kansas City, Mo.

H. D. Kemp has become affiliated with the British Munitions Company, Ltd., Montreal, Canada.

A. G. Christie is the author of an article on Calgary's Principal Power Plant, which appears in the March 14 issue of Power.

Reginald Trautschold has contributed a paper on Jackets for Gas and Oil Engines to the March 15 issue of the Practical Engineer.

S. F. Savage has accepted the position of mechanical engineer with Harry R. Westcott, consulting engineer of New Haven, Conn.

J. A. LeBlond was elected secretary of the Cincinnati branch of the National Metal Trades Association, at the annual meeting, March 3.

Robert T. Kent is the author of an article on Transmitting Power by Leather Belting, which appears in the March 2 issue of The Iron Age.

Leon C. Welch, superintendent of the cygnet division of the Buckeye Pipe Line Company, Cleveland, O., has been transferred to Lima, O.

H. A. Cozzens, Jr., has contributed an article on Testing Plant Materials for Break-Down Voltage to the March 11 issue of Electrical World.

G. L. Knight has contributed an article on Building an Unusual Foundation for a Heavy Machine, to the March 2 issue of Engineering News.

Frederick A. Geier, president of the Cincinnati Milling Machine Company, sailed from New York, March 11, for a month's cruise in the West Indies.

A brief article on Planning Delivery Dates in a Textile-Machine Plant by Arthur O. Berry, appears in the March 16 issue of the American Machinist.

Carroll E. Adams has severed his connection with Jenks and Ballou to accept the position of engineer with the Glenlyon Dye Works of Saylesville, R. I.

Dugald C. Jackson of the Massachusetts Institute of Technology, will talk on High-Power Traction before the Detroit Engineering Society, April 7.

John McK. Ballou, formerly with the Babcock and Wilcox Company, Bayonne, N. J., has entered the employ of the Ford Marine Appliance Company of New York.

David C. Fenner, formerly in the employ of the General Vehicle Company, Inc., New York, has become identified with the International Motor Company of New York.

An informal library talk, illustrated by lantern slides, on Engineering Fallacies, was given by H. de B. Parsons, Manager, Am.Soc.M.E., at the March 30 meeting of the Brooklyn Engineers' Club.

Curtis A. Mees has resigned as designing engineer of the Southern Power Company, Charlotte, N. C., and will engage in practice as consulting engineer at Charlotte, N. C., after May 1.

J. E. Lawton, for the last nine years inspector and chief inspector of The Panama Canal, has resigned to accept a position as consulting engineer and sales manager for Ward and Company, manufacturers' agents, at Washington, D. C.

A. D. Stancliff, until recently in the employ of the Texas Portland Cement Company, Dallas, Tex., as field engineer, has become identified with the Hawkeye Portland Cement Company, Des Moines, Ia.

L. M. Allison has become associated with the aeronautical department of the Polson Iron Works, Toronto, Canada. He was until recently in the employ of the Sturtevant Aeroplane Company, Boston, Mass., as chief draftsman.

Frederick P. Nehrbas has severed his connections with the Lyons Atlas Company, Indianapolis, Ind., as factory manager, to accept a position with the Premier Motor Corporation of the same city in the capacity of production manager.

E. P. Worden, until recently connected with the Fred. M. Prescott Steam Pump Works, Milwaukee, Wis., as manager, has been appointed chief engineer of Henry R. Worthington, Harrison, N. J.

Russell J. Hawn has accepted the position of manager with the Ohio Chemical Company of Springfield, O. He was until recently connected with the Virginia Portland Cement Company, Fordwick, Va., as manager.

Arthur Walser returned, April 1, to Rio de Janeiro, Brazil, where he is connected with the Brazilian General Electric Company as engineer, after spending a few weeks at the Schenectady, N. Y., works of the General Electric Company.

H. M. Montgomery and C. W. Humphrey, consulting and contracting engineer, have formed a partnership under the firm name of Humphrey and Montgomery, with offices at 327 S. La Salle Street, Chicago, Ill.

George H. Houston until recently connected with the Root and Van Dervoort Engineering Company, East Moline, Ill., in the capacity of superintendent, has become associated with the Premier Brass and Forgings Company, Cleveland, O.

Boyd Nixon has accepted a position with the Niles Tool Works Company, Cleveland, O. He was until recently Pacific coast representative of the Eastern Machine Tool Builders of Glassboro, N. J.

Daniel M. Rugg has become associated with the Gas Machinery Company of Cleveland, O. He was formerly connected with the Chattanooga Gas and Coal Products Company, Chattanooga, Tenn., in the capacity of superintendent.

William L. Saunders was the principal speaker at the sixth annual banquet of the Westinghouse employees in the Pittsburgh district, held at the Fort Pitt Hotel, March 11, under the auspices of the Westinghouse Club. Mr. Saunders chose for his subject, Industrial Preparedness for Peace and War.

Robert G. Nye, for the past $5\frac{1}{2}$ years connected, in various capacities, with the Buffalo Forge Company of Buffalo, N. Y., has tendered his resignation as factory manager to accept a similar position with the Alberger Pump and Condenser Company of New York at the Newburgh works.

Papers by Robert W. Hunt and H. B. MacFarland on The Nick and Break Test in the Inspection of Steel Rails, and Test of Douglas Fir Bridge Stringers, respectively, were presented at the 17th annual convention of the American Railway Engineering Association held in Chicago, March 21 to 23.

William Tietze has accepted the position of chief engineer with Cudahy Brothers Company, Cudahy, Wis. He was formerly affiliated with the Pierce Phosphate Company, Pierce, Fla., as chief engineer of power plants.

Arthur L. Westcott, formerly assistant professor of mechanical engineering at the University of Missouri, Columbia, Mo., has been appointed superintendent of buildings of the University. This position includes the supervision of the University lighting, heating and plumbing plant.

C. M. Wilkinson has accepted a position with the Briscoe Motor Corporation, Jackson, Mich., in the capacity of superintendent of buildings. He was formerly associated with M. C. Schwab, consulting engineer of Chicago, Ill., as engineer and construction superintendent.

F. Leroy Newcomb has left the employ of the Standard Oil Company of New Jersey with which he was connected as assistant chief draftsman in the general engineering department, to accept the position of draftsman with the Ammo-Phos Company of New York.

Lester B. Paterson, formerly electrical tester at the Van Nest electrical shops of the New York, New Haven and Hartford Railroad, Van Nest, N. Y., has been appointed scheduling engineer with the same railroad, with headquarters at the Readville, Mass., shops.

Daniel W. Mead, formerly professor of hydraulic and sanitary engineering at the University of Wisconsin, Madison, Wis., has announced his association with F. W. Scheidenhelm in the practice of engineering, with offices in the Equitable Building, New York.

P. P. Bourne, formerly chief engineer of Blake and Knowles Steam Pump Works, East Cambridge, Mass., is again associated with the International Steam Pump Company in connection with special engineering work, with headquarters at the New York office.

George K. Parsons, until recently associated with the American Vulcanized Fibre Company of Wilmington, Del., has opened offices in the Equitable Building, New York, and also in the Riggs Building, Washington, D. C., to practice consulting engineering.

Ellis Soper of the Soper Engineering Company of Chattanooga, Tenn., construction engineer on the Market Street Bridge, has been appointed chief engineer of design and construction of the plant of the Cuban Portland Cement Company, Havana, Cuba.

E. T. Spidy is the author of an article entitled The Locomotive: From Early Efforts to Modern Developments, which was read before the Western Canada Railway Club, Winnipeg, Man., and published in the March 9 issue of Canadian Machinery.

At the 14th annual meeting of the Worcester branch of the National Trades Association, March 10, Jerome R. George was elected president, and Geo. I. Alden and Albert J. Gifford were elected members of the executive board. John W. Higgins, retiring president, was made an honorary member of the Association.

A. V. Wadsworth, for many years foreman in the shops of the National Transit Company, Oil City, Pa., and for the past four years general superintendent of the Buckeye Traction Ditcher Company, Findlay, O., has accepted the position of general manager of the Dayton Pipe Coupling Company, Dayton, O.

Thomas R. H. Murphy, former member of Joseph H. Wallace and Company, New York, has recently become identified with the engineering staff of the Mattagami Pulp and Paper Company, Ltd. Mr. Murphy will be the company's resident engineer in charge of building their hydro-electric power development and a 75-ton high grade bleached sulphite pulp mill at Smooth Rock Falk, Ontario, Canada.

George M. Basford, chief engineer of the railroad department of Joseph T. Ryerson and Son, has severed his connection with that company to assume the duties of president of the Locomotive Feed Water Heater Company, New York. This company, which has just been organized, will develop and handle for locomotive use the film heater designed and patented by Luther D. Lovekin, chief engineer of the New York Ship Building Company. E. A. Averill, formerly with the Standard Stoker Company, New York, is connected with the new company in the capacity of vice-president. Mr. Basford will also form the G. M. Basford Company to handle the advertising accounts of a number of railway supply concerns.

NECROLOGY

ERASMUS DARWIN LEAVITT

Erasmus Darwin Leavitt, Honorary Member and oldest living Past-President of the Society, died in Cambridge, Mass., on March 11, 1916, where he lived for many years. He was born in Lowell, Mass., on October 27, 1836.

He received his education in the public schools of Lowell, and in 1852 he entered the Lowell Machine Shop as an apprentice, where he served for three years, after which he was employed by Corliss & Nightingale for one year. In 1858 he was employed by Harrison Loring at the City Point Works at South Boston as assistant foreman, and had charge of the construction of the engine of the U. S. S. (flagship) Hartford. From 1859 to 1861 he was chief draftsman for Thurston, Gardner & Co., Providence, R. I., then among the few builders of high class steam engines; from there he entered the United States Navy in 1861.

He served in the Navy during the Civil War, and until 1867, when he resigned. During this time he saw service on the gunboat Sagamore in the Eastern Gulf Squadron from September, 1861 until July, 1863, when he was promoted to the office of second assistant engineer, and afterwards was engaged in construction duty at Baltimore, Boston and Brooklyn. Two years later he was detailed to the Naval Academy at Annapolis as instructor in steam engineering, and from there resigned from the service.

He immediately (1867) entered the practice of mechanical engineering and from that time began to be well known and became, probably, the most prominent mechanical engineer in office practice in the United States.

In 1869 a simple condensing engine having a steamboat walking beam and cam valve gear was built from his design for the Plymouth Cordage Co. by Harrison Loring at the City Point Works, Boston, Mass. The engine is still in working order, but has a Corliss cylinder and valve gear. Mr. Leavitt remained consulting engineer for the Plymouth Cordage Co. from that time until two or three years ago, when poor health caused him to resign. Mr. Gideon F. Holmes, late treasurer of that company, stated some years ago that nothing but good came to the Plymouth Cordage Co. from Mr. Leavitt's connection with it.

Mr. Leavitt's fame as an engineer may be said to have begun with the installation of the pumping engine at Lynn, Mass. The economy of pumping engines had long interested him, and

with the assistance of George H. Norman of Newport, R. I., he was able to design an engine for Lynn that embraced all his ideas for economy. This engine was a beam compound, the cylinders being at the bottom and the beam overhead. The cylinders were inclined, and had their lower ends together, and one drove one end of the beam and the other the other end. The pump was vertical and connected to one end of the beam, and the connecting rod on the other. The Thames-Ditton bucket and plunger pump was used, the suction being single and the discharge double acting. After this, Mr. Leavitt adopted differential plungers, these being single acting on the suction and double on the discharge.

This engine marked an era in the economy of pumping engines throughout the world. It was officially tested by W. E. Worthen, J. C. Hoadley, James P. Kirkwood, Charles Hermany and Joseph P. Davis, their final report being dated June 1, 1874. The duty was based upon the work done per hundred pounds of coal and the quantity of water was determined by weir measurement. The duration of the test was from 11 a.m., December 10, until 3 p.m., December 12, 1873, or 52 hours, without a stop. Upon this basis the duty was 103,923,215 ft. lb. per 100 lb. of picked Lackawanna anthracite coal.

The Lynn engine was quickly followed by a pair of similar engines coupled together, but of somewhat larger size, for the water works of Lawrence, Mass. The test was conducted by W. E. Worthen, J. C. Hoadley, and Joseph P. Davis, and a duty of 96,186,979 ft. lb. of work per 100 lb. of coal was reported, the water being measured by a weir. In the report of this test was included a combined indicator diagram, which was the first, probably, to be made in this country. It was plotted by Mr. Hoadley, and its appearance caused much interest among engineers, and the use of the word "adiabatic" in connection with it created a new interest in the behavior of steam.

Upon the recommendation of James B. Francis, the famous hydraulic engineer of Lowell, Mr. Leavitt was appointed consulting and mechanical engineer of the Calumet & Hecla Mining Co. in 1874, a position which he retained until 1904. Here Mr. Leavitt had many opportunities to display his powers as a designer of heavy machinery for pumping, general power purposes, hoisting, and stamping.

Water was needed in large quantities for condensing, washing out copper, and domestic consumption for the town of Calumet. Mr. Leavitt abandoned the Lynn type of pumping engine, placed the beam at the bottom and the steam cylinders above. At first one cylinder only was inclined and the other vertical, but soon afterwards both cylinders were vertical, the pumps in all cases being below and vertical. At the time of placing both cylinders vertical, instead of having the high pressure exhaust and low pressure inlet valves work simultaneously, as previously, the latter was made a cut-off valve and re-heaters were placed between the cylinders. The engine was thus changed from having continuous expansion through both cylinders to one having interrupted expansion, but no doubt with improved economy.

The engine "Superior," with cylinders 40 in. and 70 in. diameter, stroke 6 ft., 60 r.p.m., was the largest engine built for the Calumet & Hecla Co. This was an inverted compound beam engine and was used for driving hoisting drums and air compressors. The connecting rod ran from a pin in the top of the beam, and the crank was at one end. The crank was double armed and drove in both directions, the hoisting machinery being on one side and the air compressors on the other. The crank pin was 18 in. by 24 in. The flywheel was 36 ft. in diameter and was also a belt wheel.

As the plant used a great deal of compressed air Mr. Leavitt had necessarily to consider the problem of its supply, and after a time designed some 42 in. x 60 in. wet compressors in pairs. Two pairs of this design were built, but later additions were dry compressors.

Water was used at the stamp mills more than elsewhere, and after building several ordinary sized pumping engines for this work, he built one of 60 million gallons capacity in 24 hours. This had two plungers of 48 in. diameter and its stroke was 90 in.

Up to 1886 Mr. Leavitt's standard steam pressure was 135 lb. per sq. in., but in that year he began the design of triple expansion engines and adopted 185 lb. pressure. His triple expansion engines were modifications of the compound in having the high and intermediate pistons operate on one end of the beam and the low on the other. Engines of this type for hoisting, pumping and general power work were designed but later some with three cranks were built.

One of the most important pieces of work he did for the Calumet & Hecla Co. was the improvement in steam stamps by which a very important economy and rapid stamping were secured. The Leavitt stamp consisted of a steam cylinder having two pistons, one with boiler pressure on top to deliver the blow and the other with reduced pressure constantly under the other piston for the purpose of lifting the stamp, and this steam squeezed back to the boilers with every downward stroke. These stamps were operated condensing.

Mr. Leavitt was a very strong advocate of gridiron valves and all his designs employed them. He was equally strong in his advocacy of cams for operating them, but some of his later designs employed other mechanism with dash pots.

Still another field for good engineering appeared in an opportunity to change the construction of the sand wheels from wood—the construction used in the Lake Superior region—to metal, and Mr. Leavitt designed sand wheels of 50 ft. and 60 ft. diameter on the principle of the bicycle wheel.

The hoisting gear used with constant running engines opened again another field in the operation of brakes and clutches, and here Mr. Leavitt employed hydraulic cylinders and accumulators. In some of the later hoisting engines, reversing engines were used in connection with the Whiting system.

While Mr. Leavitt was employed by the Calumet & Hecla Co. he was frequently engaged by other companies and municipalities, and found time to act as consulting engineer for Henry R. Worthington, The Dickson Mfg. Co. and the Bethlehem Steel Co.,—for the former company when they developed their high duty direct acting pumping engine, and for the latter when the plant at Bethlehem was being modernized and hydraulic forging introduced. For pumping water for the forging presses of the Bethlehem Co., he designed a 3-cylinder 3-crank simple non-condensing vertical beam engine to drive pumps designed and built by the company.

For the Dickson Mfg. Co. he designed a pair of remarkable 30 in. x 60 in. x 60 r.p.m. engines for the Washington Mills of the American Woolen Co. at Lawrence, Mass. These have been continuously in operation since the spring of 1887.

He designed the first engines used for the cable railway of the Brooklyn Bridge; engines, boilers and other machinery for the El Callao Mining Co. of Venezuela; three immense sewage pumping engines for the City of Boston, one being of 75 million gallons capacity in twenty-four hours; a pumping engine of 15 million gallons capacity for the Louisville Water Works which upon being tested for six days and six nights without stopping surpassed all previous records for economy in steam consumption; a large engine for the Cambridge Water Works;

two engines for the New Bedford Water Works; a large engine for the Boston Water Works, etc.

Mr. Leavitt was a strong advocate of the locomotive type boiler and used it almost exclusively, the diameter of the shell being usually 90 in. in diameter.

After 1888 he made frequent visits to Europe, where his fame had preceded him. He became well acquainted with the leading engineers in several countries; among these was Professor Riedler of Berlin, from whom he acquired the right to use the Riedler pump valve and gear in this country; the Boston engine mentioned above is equipped with this gear. He was in intimate relationship with the Krupps, and by their invitation was present on their yacht "Rona" at the opening of the Kiel Canal.

Mr. Leavitt was one of the thirty mechanical engineers who organized The American Society of Mechanical Engineers in 1880. Of his standing at that time the History of the Society by Prof. F. R. Hutton says:

"Mr. E. D. Leavitt was best known for his notable successes in the design of high duty compound pumping engines for city water works service; he was then (1880) on the point of completing the 'Superior,' the great engine for the Calumet & Hecla Copper Mining Company. He stood for high economy in slow speed engines and with an elaborated valve gear, just as Mr. Charles T. Porter stood for economy in the type operating at high rotative speeds with simple valve gear.

"He served as President of the Society during 1882-83, a very critical time in the life of the Society.

"Mr. Leavitt's first meeting (over which he presided) was the very successful Cleveland meeting, at which for the first time the papers to be read were furnished to members, and particularly to the technical press on printer's galleys.

"He positively declined a second term as President on the principle . . . that the honor of office should be widely conferred, even at a loss of the possible greater effectiveness which might be secured by longer service."

Mr. Leavitt was on intimate terms with the most prominent American engineers of his active days, including James B. Francis, John Fritz, Charles T. Porter, Alexander L. Holley, Henry R. Worthington, Washington Jones, John E. Sweet, Robert H. Thurston, S. B. Whiting, John C. Hoadley, W. E. Worthen, James P. Kirkwood, Joseph P. Davis, Alphons Fteley, Charles Hermany, John A. Roebling, William Sellers, Coleman Sellers, Samuel T. Wellman, and George W. Melville.

He was of a very modest and retiring nature, and his acquaintance with the younger members of the Society was not extensive and many of them probably never saw him. In later years he did not attend the meetings frequently, and when he did he sought the companionship of the older men.

Of Mr.Leavitt as a designer, it can be said that he did more than any other engineer in this country to establish sound principles and propriety of design. He appreciated the importance of directness and the absence of ornamentation in strictly utilitarian designs, and he firmly believed that beauty in machine design came from propriety. He bore the same relation to good taste in the design of heavy machinery that William Sellers did in the design of machine tools.

He was a very strong advocate of good materials and good workmanship, and had a singular appreciation of what gave stability and permanence to machinery. He was among the very first engineers in this country to appreciate the importance of weight in machinery, and while many Americans were advocates of light weight, Mr. Leavitt's view has amply been vindicated by the present status and tendency of design in this country.

In his Calumet and Hecla machinery he held the view that the best was none too good, and that it was of the utmost importance to have machinery which could be depended upon to do its work, always of the severest kind, without interruption. The service was twenty-four hours a day, and interruption of production was very costly.

Mr. Leavitt received the degree of Doctor of Engineering from the Stevens Institute of Technology in 1884, and was the first recipient of this degree from the Institute. He was not only an original member of The American Society of Mechanical Engineers, but was made an Honorary Member on January 12, 1915; he served as a Vice-President in 1881-82 and as President in 1883. He was a member of the Institution of Mechanical Engineers of England for thirty-three years, and was made an Honorary Member on February 18, 1916. He was a member of the following societies: Institution of Civil Engineers of Great Britain; American Society of Civil Engineers; American Institute of Mining Engineers; Boston Society of Civil Engineers (Honorary, 1908); American Society of Naval Engineers (Honorary); British Association for the Advancement of Science (Life Member), The Franklin Institute, and the New England Water Works Association (Honorary, 1906). He was a Fellow of the American Academy of Arts and Sciences.

He was for many years on the Visiting Committee of the Engineering Department of Harvard University and of the Observatory.

In general business Mr. Leavitt did not make himself prominent, but he was a director for many years of the Harvard Trust Co. of Cambridge, and was very much interested in the Cambridge Young Men's Christian Association. He was also a member of the board having charge of the construction of the new West Boston Bridge between Boston and Cambridge.

Mr. Leavitt's health was never robust, and in consequence of this he worked under considerable disadvantage for much of the time.

CHARLES J. H. WOODBURY

By the death of Erasmus D. Leavitt on March 11 and of Charles J. H. Woodbury on March 20, the Society loses in the same month two of its original members, both of whom early held office and both of whom inaugurated important developments in the Society's work.

Charles J. H. Woodbury was born at Lynn, Mass., on May 4, 1851, and resided there during his life. He received his education in the public schools of Lynn, and from there he entered the Massachusetts Institute of Technology in the course of civil engineering, graduating in 1873.

He began the practice of his profession in the city engineer's office in Lynn during his vacations while at college, and was later superintendent of a mill at Rockport. He became engineer of the Boston Manufacturers' Mutual Fire Insurance Company in 1878, and later vice-president, and while with the company he made numerous investigations on fire hazards in mill construction, lubricating oils and electric lighting, and invented several improvements in automatic sprinklers. He also reorganized the company's methods of inspection and reports upon mill property. In 1894 he became assistant engineer of the American Bell Telephone Company, which position he held until the removal of the company to New York in 1907, when he took up private practice as a consulting engineer.

Dr. Woodbury was the author of Fire Protection in Mills, 1882, Telephone Line Engineering; The Telephone System, 1899, and Bibliography of Cotton Manufacture, 1909. Also,

he wrote numerous monographs and papers on fire protection, political economy and engineering, many of which are incorporated in the proceedings of the scientific and engineering societies.

He was the originator of a number of valuable inventions, and on three occasions received awards for them. The Société Industrielle de Mulhouse awarded him the Alsacian Medal in 1883, the city of Philadelphia conferred on him the John Scott Medal in 1885, and in 1910 he received the Association Medal from the National Association of Cotton Manufacturers. Further recognitions for his contributions to science and engineering came to him from Tufts College in 1893, when he received the honorary degree of Master of Arts from the college, and he was made an honorary Doctor of Science of Union College in 1906 and of Dartmouth College two years later.

Dr. Woodbury was a member of the American Society of Civil Engineers; the American Institute of Electrical Engineers; the National Association of Cotton Manufacturers, of which he was secretary and treasurer since 1894; the Society of Arts, and the Sons of the American Revolution. He was a fellow of the American Academy for the Advancement of Science, and an honorary member of the New York Telephone Club. He was a non-resident lecturer at the Massachusetts Institute of Technology and also at Cornell University. From 1886 to 1895 he was chairman of the Lynn School Committee.

Dr. Woodbury was elected to membership in our Society in 1880, and he served as Vice-President from 1887 to 1889.

To him is due the initiation of our Library. At the meeting of the Council on February 15, 1883, he moved that the Secretary be instructed to request from members circulars of manufacturing establishments and reports of engineering operations, with a view to making a catalogue of contemporaneous engineering work, to be filed properly and placed at the service of members. The motion was carried and put into effect, and the response was prompt and liberal, many of the technical periodicals contributing copies of their publications, and some sending complete bound files of their back numbers. As the outcome a standing committee on the library was appointed, which recommended the definite organization of the Library.

The President appointed the following as Honorary Vice-Presidents to represent the Society at Dr. Woodbury's funeral: G. I. Alden, Gardner C. Anthony, H. S. Baldwin, Albert G. Duncan, C. H. Fish, W. A. Hall, Franklin W. Hobbs, W. R. Park, George F. Swain, J. A. Tilden, A. C. Walworth, A. K. Warren, H. S. Baldwin, G. H. Barrus, John A. Stevens, Richard H. Rice, C. T. Plunkett, E. F. Greene, E. W. Thomas, C. T. Main.

JOHN W. HILL

John W. Hill was born in Liverpool, England, on July 12, 1865, and received his early education there. From 1880 to 1884 he served an apprenticeship as machinist with Daniel Adamson & Co. From 1890-1899 Mr. Hill was at the Watervliet Arsenal, with E. D. Leavitt of Cambridge, Mass., and the General Electric Company as draftsman and designer. After leaving the General Electric Company, he was superintendent of the Steamobile Company at Keene, N. H., and also superintendent of the Roller Bearings Company. He was later employed with the Maxwell Brisco Company in charge of the department of tooling up machines for rapid jig construction of automobiles.

In 1911 he entered the employ of the Bantam Anti-Friction Company as mechanical and sales engineer in charge of the Detroit office and the northwestern territory.

Mr. Hill was a member of the Society of Automobile Engineers, and a member of this Society since 1899. He died at his home in Detroit on February 12.

FREDRIK V. MATTON

Fredrik V. Matton was born in Stockholm, Sweden, on June 6, 1856. He received his technical training at Stats College and served his apprenticeship as a machinist in his native country. He came to this country early in 1882, first securing employment at Altoona and later at the Harrison Sugar Refinery at Philadelphia. While there he had charge of the repairs and construction of general machinery.

In June, 1885, Mr. Matton became employed at the Camden Iron Works in Camden, N. J., as chief engineer, which position he held until his last illness.

Mr. Matton became a member of the Society in 1892. He died at Atlantic City on December 3, 1915.

DAVID THOMPSON

David Thompson was born at Castlemaine, Victoria, Australia, on December 5, 1865. He received his early education in the state and public schools and in the School of Mines. He served an apprenticeship in the Castlemaine Foundry of the Thompson Company, manufacturers of mining and general machinery, which was founded by his father. From 1882 to 1887, he was engaged in making detail drawings for all classes of mining machinery, engine boilers and pumping gears, and in 1887 became assistant works manager at the Castlemaine Foundry. Since 1891 he has been managing partner of the Foundry, which are at the present time the largest privately owned ironworks in Australia.

Mr. Thompson was very much interested in the welfare of the working classes and sat on all wage boards in Melbourne in connection with the iron trade and was largely instrumental in fixing the rates of wages. He was also a member of the Chamber of Manufacturers and acted on various committees associated with that Chamber.

Mr. Thompson became a member of the Society in 1905. His death, which was the result of an accident in the works at Castlemaine, occurred on February 6, 1916.

WILLIAM ALFRED PERRY

William Alfred Perry was born in Brooklyn on April 22, 1835. He received his early education at Mr. Howard's Day School in Brooklyn and graduated from Columbia College in 1855. The following year he became a clerk in the firm of Henry R. Worthington, and 13 years later became first a partner and later vice-president of the same firm. He was also a director in the Union Ferry Company.

The first propeller ferry boat with guards that ran in New York Bay was built under his direction by the firm of Pusey Jones & Company of Philadelphia in 1867.

Mr. Perry was a member of the University, Century and Engineers' Club. He became a member of this Society in 1880. He died at his home in New York City on February 16, 1916.

HARRY SHAFER PELL

Harry Shafer Pell was born in Lykens, Dauphin County, Pa., on July 23, 1846. He received his early education in the public schools and in 1860 entered the employ of the Lykens Valley Railroad Company as an apprentice machinist and blacksmith. From 1871 until 1873 he was master mechanic and later engineer for the Vulcan Iron Works. From 1873 until 1881 he was shop foreman for Tolten and Company of

Pittsburgh. He was also engineer for St. Louis Ore and Steel Company, in the machinery and foundry business at Minneapolis, superintendent in charge of the shops and all construction work for Jas. P. Witherow of New Castle, Pa., and engineer and superintendent for The Stirling Company of Barberton, Ohio, manufacturers of the Stirling boilers. While there he had charge of the engineering department, shops and erection, as well as all of the purchasing of materials. For the past few years Mr. Pell has been chief engineer of the water tube boiler department of the Erie City Iron Works.

Mr. Pell died at his home in Erie, Pa., on March 1, 1916.

SOCIETY MEETINGS

It is of the highest importance in the development of the monthly meetings of the Society, both of the Sections and of the Student Branches, that comprehensive reports of these meetings be published in The Journal regularly. Secretaries of the sections and student branches are urged to make every effort to get the complete reports of their meetings to this office as quickly as possible after the meetings are held, and also where possible, copies of the papers presented should be sent in; if desired, the copy of the paper will be returned after examination. The reports of meetings in order to appear in the next issue of The Journal must be received in this office before the 18th of the month.

PHILADELPHIA, FEBRUARY 3

On February 3 a joint meeting of the Philadelphia Section of the Society was held with The Franklin Institute, at which Charles Day of The Franklin Institute and Professor Fernald of the Am.Soc.M.E. presided. The paper presented was on The Development of the Pumping Engine, by Arthur M. Greene, Jr., Mem.Am.Soc.M.E., professor of mechanical engineering at Rensselaer Polytechnic Institute.

WORCESTER, FEBRUARY 16

At a meeting of the Worcester Section of the Society held on February 16, Dr. Ira N. Hollis, president of the Worcester Polytechnic Institute, spoke on What Constitutes a Well Rounded Fleet. The conclusion that Dr. Hollis came to was that in any program of building up a fleet due consideration must be given to the different units of a fleet in order to make its fleet action effective. Battleships without the necessary auxiliaries seriously handicap their full use.

PROVIDENCE, FEBRUARY 23

A meeting of the Providence Association of Mechanical Engineers was held on February 23, at which Prof. James A. Hall, Mem.Am.Soc.M.E., addressed the meeting on The Handling of Steam Coal from the Mine to the Consumer.

CINCINNATI, FEBRUARY 24

A joint meeting of the Engineers' Club of Cincinnati and the Cincinnati Section of the Society was held on February 24, at which Morse W. Rew, assistant engineer of the Board of Rapid Transit Commissioners, gave an illustrated lecture on a Rapid Transit System and Interurban Facilities for the City of Cincinnati. The fact that the people of Cincinnati will be called upon to vote for or against a proposed issue of $6,000,000 for this rapid transit scheme on April 25, 1916, made the lecture even more interesting. Mr. Rew discussed the needs of such a system in Cincinnati, advantages accruing to the individual and to the business man, as well as to the community as a whole. He told what that city might expect from the Rapid Transit System as an aid to suburban development, and gave statistics of what has resulted in the various cities which now have subways. He also gave statistics disproving the popular idea that subway travel is more dangerous than surface, elevated and other methods of transportation.

The question of who would operate the proposed system was touched upon, and Mr. Rew stated that if the bond issue of $6,000,000 is approved by vote of the people, the Rapid Transit Commission proposes to lease the system on the best terms possible to an operating company, subject to the approval of the people, such approval being asked at a special election to be held prior to letting any contracts for construction work. He closed his address with a brief engineering description of the route and of the different types of construction that will be used on the proposed system.

BUFFALO, MARCH 1

At a meeting of the Buffalo Engineering Society on March 1, T. Kennard Thomson, Mem.Am.Soc.M.E. and consulting engineer of New York City, spoke on The Problems of a Consulting Engineer. Mr. Thomson outlined his plan for the extension of Buffalo by a development of the submerged land along the water front, consisting of about seven square miles, which could be used in developing industrial and recreation facilities. He proposed to use a part of this new filled-in land for the freight and passenger terminals of the railroads and boat lines, and stated that the cost of this work could be financed with the proceeds of sale of the new land. Mr. Thomson, together with Peter A. Porter of Niagara Falls, had also plans for the construction of a new electric power plant. They proposed to use the natural drop of 102 ft. in the river between the Falls and Lewiston by the construction of an enormous dam. It would then be possible, the speaker stated, to create 2,000,000 h.p. as compared to the 1,000,000 h.p. now being obtained from the power plants at the Falls.

Dr. Thomson, who is consulting engineer of the American Commission for the celebration of 100 years peace between Great Britain and the United States, described the plans for the proposed peace bridge across the Niagara River at Ferry Street. Specifications call for a bridge one mile in length and 100 ft. wide, with six main spans of 300 ft. each. The spans would be the widest of the kind in existence.

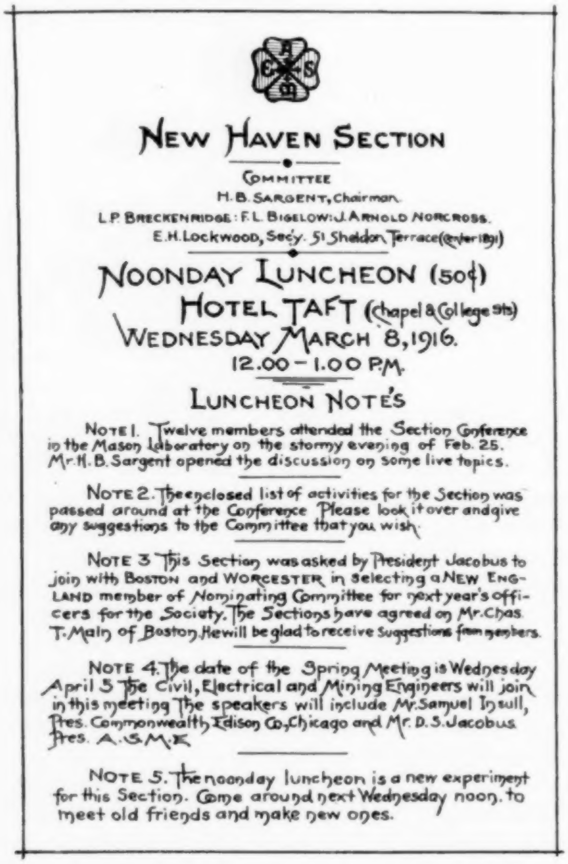
BIRMINGHAM, MARCH 2

A business meeting of the Birmingham Section of the Society was held on March 2 at which 16 members were present. The new Constitution and By-Laws were adopted and other routine business matters cared for. The greater part of the discussion, however, was devoted to the coming visit of the Society to Birmingham on April 10. The Section is anxious to see a large number of members in Birmingham on

the 10th and is making extensive plans to give everyone a good time.

NEW HAVEN, MARCH 8

A second informal meeting of the New Haven Section was held on March 8 and was followed by a noon-day luncheon. Social meetings of the New Haven Section have now become a regular feature, but will not interfere with the large meetings held twice a year for reading of papers. Fig. 1 shows the program which was distributed at the luncheon, upon which appears general notes which are of immediate interest to the New Haven members. The first of these informal meetings was held on February 25 and it was devoted principally to promoting mutual acquaintance and to a discussion of the interests of the New Haven Section. At this meeting there were distributed sheets on which appeared possible procedures that the New Haven Section might follow in promoting the welfare of the Society and the local members, and also several suggestions which had been sent in by a member.


NEW HAVEN SECTION

COMMITTEE

H. B. SARGENT, Chairman.

L. P. BRECKENRIDGE: F. L. BIGELOW: J. ARNOLD NORCROSS.

E. H. LOCKWOOD, Sec'y. 51 Sheldon Terrace (Center 1891)

NOONDAY LUNCHEON (50¢)

HOTEL TAFT (Chapel & College Sts)

WEDNESDAY MARCH 8, 1916.

12.00 – 1.00 P.M.

LUNCHEON NOTES

NOTE 1. Twelve members attended the Section Conference in the Mason Laboratory on the stormy evening of Feb. 25. Mr. H. B. Sargent opened the discussion on some live topics.

NOTE 2. The enclosed list of activities for the Section was passed around at the Conference. Please look it over and give any suggestions to the Committee that you wish.

NOTE 3. This Section was asked by President Jacobus to join with BOSTON and WORCESTER in selecting a NEW ENGLAND member of Nominating Committee for next year's officers for the Society. The Sections have agreed on Mr. Chas. T. Main of Boston. He will be glad to receive suggestions from members.

NOTE 4. The date of the Spring Meeting is Wednesday April 5. The Civil, Electrical and Mining Engineers will join in this meeting. The speakers will include Mr. Samuel Insull, Pres. Commonwealth Edison Co., Chicago and Mr. D. S. Jacobus Pres. A.S.M.E.

NOTE 5. The noonday luncheon is a new experiment for this Section. Come around next Wednesday noon, to meet old friends and make new ones.

FIG. 1 ATTRACTIVE PROGRAM OF NOON-DAY LUNCHEON AT NEW HAVEN

MINNESOTA, MARCH 9

The regular March meeting of the Minnesota Section of the Society was held on March 9 at the offices of the St. Paul Gas Light Company in St. Paul. Following the business session, Herman F. Mueller presented a paper on the Uniflow Engine. It consisted mainly of a description, the origin of the Uniflow engine in Germany, together with its manufacture, auxiliaries used in its operation, efficiency, etc. A general comparison was also made with other steam units in general use in this country.

BOSTON, MARCH 14

The Boston Section of the Society held a meeting on March 14 at which George H. Clarke of the mechanical engineering staff of the Massachusetts Institute of Technology presented an illustrated lecture on Safety Valves. Mr. Clarke has spent much time in investigations and tests of safety valves and has brought out some new and valuable principles of construction. The speaker covered his subject under the following topics:

a. Present state of the art and the available theory for design.

b. Absolute and imperative need of valves of higher discharge capacities.

c. The limiting possibilities of the spring loaded type and the portion attained by standard valves.

d. Reasons why the standard valves cannot be designed for increased capacities.

e. Theoretical considerations which should govern the design and do govern the action of all safety valves.

f. Description of a new type, its theory, the results attained on test and the advantages of the design.

A lengthy discussion followed the presentation of the paper on which the following gentlemen participated: Prof. Edward F. Miller, Mem. Am.Soc.M.E. and of the Massachusetts Institute of Technology; George H. Musgrave of the Star Brass Manufacturing Company, Mr. Pirie of the Crosby Steam Gage and Valve Company, John A. Stevens, Mem. Am.Soc.M.E. and consulting engineer of Lowell, Mass.; A. B. Carhart, Mem.Am.Soc.M.E. and of the Crosby Steam Gage & Valve Company; Mr. Edwards of the Wentworth Institute, Frank E. Fairbanks, Mem.Am.Soc.M.E. and of the Quincy Market Cold Storage Company, and F. W. Dean, Mem. Am.Soc.M.E. and consulting engineer of Boston.

NEW YORK, MARCH 14

The March meeting of the New York Local Section was a joint meeting of the Section and of the New York Section of the Illuminating Engineering Society to discuss the Code of Lighting for Factories, Mills and Other Work, prepared by committees of the latter Society. Prof. C. E. Clewell, Assistant Professor of Electrical Engineering, University of Pennsylvania, who assisted in the preparation of the code, opened the discussion by analyzing the causes which have led to greater attention on the part of factory owners and employers to the conditions under which their employees work, giving the reasons for the preparation of the code, discussing its probable field of usefulness and explaining points most likely to advance the status of factory lighting and raise the standards of quantity and quality of light for industrial purposes. Professor Clewell illustrated his remarks by a number of lantern slides.

L. P. Alford opened the discussion for the Society, and took up in detail the phraseology of the code. Following this, the code was discussed by several members of the Society and of the Illuminating Engineering Society, and a vote of thanks was extended to those who had taken part in the preparation of the code and in the discussion of the evening.

The meeting was preceded by an informal dinner at which members of both societies were present.

BUFFALO, MARCH 15

On March 15, at a meeting of the Buffalo Engineering Society, Prof. Arthur M. Greene, Jr., of the Rensselaer Poly-

technic Institute, gave an address illustrated with a large number of slides on the History of Pumping Stations. The slides showed the progress that had been made from the days of the "shadouf," as used by the Egyptians for irrigation purposes, to the modern large pumping stations. The works of Savery, Newcomen, Watt, Bull, Worthington, Reynolds, Gaskill and d'Auria were illustrated to show their contributions to this development.

There were about 150 members present at the meeting.

CINCINNATI, MARCH 16

The March meeting of the Cincinnati Section of the Society, which was a joint meeting with the Engineers' Club of Cincinnati, was held on March 16. The attendance at the afternoon session was about 75 and at the evening session about 100. The total number of persons who attended one session or another was probably 125. There were present at the meeting thirty members of the Am.Soc.M.E., which is the largest number of members that has ever attended a meeting in Cincinnati. Visitors were present from Akron, Dayton and Hamilton, Ohio.

There were two papers presented at the afternoon session: The Sales Engineer in His Relation to Production and Machine Design, by A. J. M. Baker, Mem.Am.Soc.M.E., and Recent Developments in the Recovery of Casing-head Gasoline, by Paul Diserens, Mem.Am.Soc.M.E. Both of these papers were illustrated.

There were also two papers presented at the evening session, one by W. G. Franz, Mem.Am.Soc.M.E., on Why Is an Engineer? and the other by A. M. Sosa, Mem. Am.Soc.M.E., on Probable Future Requirements in Machine Tools.

CHICAGO, MARCH 17

The third meeting this year of the Chicago Local Section was held at the Hotel LaSalle on March 17, Chairman H. M. Montgomery presiding. This meeting was attended by 202 members and guests. The subject of the nomination of officers was discussed by the membership, and it was decided to follow the practice of the past and have the nominating committee nominate the full committee without any restrictions as regards rotation. The paper of the evening was prepared by S. B. Daugherty, International Steam Pump Company, Buffalo, N. Y., and was read by H. C. Lehn of the same company, as it was impossible for Mr. Daugherty to attend the meeting.

The subject of the paper was Oil Engines, and the author described in some detail both Diesel and low compression engines and gave figures of their reliability and economy. He also considered fuel and lubrication, and other vital factors. The discussion of the paper was active and interesting, many points being brought out regarding the potentialities of this type of prime mover.

PROVIDENCE, MARCH 22

The March meeting of the Providence Association of Mechanical Engineers was held on March 22. The prime matter of discussion was the enlargement of the scope of the Association and the committee which had been appointed to consider that project reported their suggestions as to changes in the present constitution to meet the new requirements. The resolutions presented are to come up for action at the April meeting of the Association.

Following the business meeting, the Association was addressed by J. W. Hook, general manager of the C. A. Dunham Co., of Marshalltown, Iowa, on Vacuum Steam Heating.

STUDENT BRANCHES

ARMOUR INSTITUTE OF TECHNOLOGY

An open meeting of the Student Branch of the Armour Institute of Technology was held during school hours on February 18. The speaker, Osburn Monnett, former smoke inspector of the city of Chicago, gave an illustrated talk on The Engineering Phases of Smoke Abatement Work. The substance of his lecture was the damage and expense incurred by smoke and his methods of remedying the smoke nuisance. He said that the soft coal smoke deposits a hard crust on buildings and that skilled labor is required to remove it; scrubbing and sand blasts have to be used in some cases. He said that the owners of the Railway Exchange Building spend $1500 yearly for this work.

Mr. Monnett said that at the beginning of this smoke work the return tubular boiler gave the greatest trouble as it made about 90 per cent of the smoke, and that his chief work was to find means of improving this boiler so that it would not smoke. He illustrated how the Ringlemann smoke chart is used to determine whether the smoke has a density of 20, 40, 60, 80 or 100 per cent. He closed his lecture by saying that abatement of smoke means city beautiful, health, more sunlight, better vegetation, clean homes, happier people.

BUCKNELL UNIVERSITY

A meeting of the Bucknell University Student Branch was held on March 6, at which O. C. Hartman, '16, gave a talk on Superheaters on Railroad Engines. The discussion covered the reasons for superheating, together with the conditions which must be met in design of locomotives of this type. The various methods of superheating used were explained by means of drawings and blueprints of the different types of locomotives and their advantages and disadvantages were brought out. A comparison was made between the superheater type of locomotive and the locomotive which uses only saturated steam.

CASE SCHOOL OF APPLIED SCIENCE

At the February meeting of the Case School of Applied Science Student Branch, held on February 2, R. R. Abbott, who is associated with the Peerless Motor Car Company as metallurgist, gave a talk on the Theory of Heat Treatment Practically Explained. The speaker gave a systematic explanation of the ferrite and pearlite compositions of steel, with the relative strength and toughness of each, and explained that alloys in the steels were used merely to change the physical properties of the steels either by increasing the strength of the ferrite or of the pearlite. Similarly he brought out the effects of heat treatment and its control on the physical properties of the various steels.

At a meeting of the branch on March 1, Prof. K. F. Adamson, Mem.Am.Soc.M.E., of the Mechanical Department, spoke on the Buckeyemobile and Uniflow Engine and showed why these types of reciprocating engines can compete with the smaller turbine units of the present time. He described in detail the Buckeyemobile, which consists of a unit of engine and boiler combined, and with the aid of data compiled by him showed the comparison of the efficiencies, economies and cost of power between this type and the modern large turbine units. His figures showed that only 1.25 to 1.5 lb. of coal per b.h.p. per hr. are used by the Buckeyemobile, which is in reality a copy of the German locomobile engine. Mr. Adamson then described in detail, using slides as illustrations, the American uniflow engine, and from typical indicator cards showed how closely the card taken from an engine of this type approaches the theoretical card; hence its high efficiency. The valve gearing, including bleeding valves, was thoroughly discussed.

COLORADO AGRICULTURAL COLLEGE

A meeting of the Colorado Agricultural College Student Branch was held on February 14, at which Mr. Gorton gave a talk on the first U. S. Government built Diesel engine. He described in close detail the engine as a whole and also the cylinders, pistons, the bed and all details of auxiliary air com-

pressors and fuel pumps. He explained the operation of the engine, the cooling system and the mounting of all parts.

Following Mr. Gorton's talk, Mr. Hoffman reviewed the paper by Robert Cramer on Higher Steam Pressures, which was published in the January 1916 issue of The Journal.

KANSAS STATE AGRICULTURAL COLLEGE

A meeting of the Kansas State Agricultural College was held on March 2, at which Prof. Walter W. Carlson, Mem. Am.Soc.M.E., gave a paper on the Composition and Use of Thermit. He gave the reactions of the compound and the results of these reactions. The action is so fast that a large amount of heat is generated which goes to melt the iron filings and makes the weld. The composition of the compound is $Fe_2O_3 + 2Al$ and by applying a source of heat to kindle the aluminum the equation $Fe_2O_3 + 2Al = 2Fe + Al_2O_3$ is derived. The aluminum has a great affinity for oxygen and is therefore used to take up the oxygen in Fe_2O_3. Thermit is used for welding metal and is also added to ladles of molten metal in the foundry to make the iron hotter and thus make it finer grain.

A second paper was presented by Mr. Slusher of Kansas City on Oxy-acetylene Welding. Mr. Slusher gave a comparison between the old and the new methods of welding and the saving that is brought about by the use of oxy-acetylene welding machinery.

The modern oxy-acetylene generator is very much improved over the old type and has reduced the danger and also the cost of the use of the machine. The oxygen and acetylene are put up in steel bottles, which reduces the danger in handling and using the gases. The torches of today are also a great improvement over the ones of five or six years ago; they are much lighter and the flame is much hotter. In the up-to-date torches the gases are mixed more thoroughly and there is less danger of back firing.

LEHIGH UNIVERSITY

A meeting of the Student Branch of Lehigh University was held on March 2. The first speaker was F. W. Ryder, '16, who read a paper on the Operation of Electric Mine Locomotives. He said that the transportation of material is a very important factor in the coal mining industry on account of the magnitude of the coal mined, which in 1910 reached the net total of 500 millions of tons.

The use of electricity in coal mines has been in vogue for many years, and the advantages of the electric locomotive over the steam locomotive have been fully demonstrated. The electric locomotive is good on grades, is superior to the steam locomotive in simplicity of construction and has a more compact form. Besides, the use of steam is difficult and costly, and diminishes the factor of safety. The gasolene type is undesirable because it develops a low efficiency. The first electric locomotive was built in 1899 and is still in daily operation.

In modern coal mines there are the straight haulage, cable reel and combination or crab types of locomotives in use. As regards the positions of the motors, there are two types: Two motors, one geared to each axle, or one motor connected to both axles. The total height is 27 in., which is smaller than any steam locomotive ever built.

The construction of the frames has undergone some important changes which have tended to increase the efficiency considerably. Formerly cast iron was used almost entirely for the frames, but now the plate steel construction has proved to be a great improvement over cast iron. Plate steel frames have decreased the weight and are much more desirable.

The bar steel frame, invented by The Baldwin Locomotive Works, is very flexible, is easily inspected and is practically proof against injury. The bodies may be either tandem hung, central hung, or low hung.

In the performance of the locomotive all the wheels must revolve at the same speed, with equal distribution of the drivers on the track. The maximum draw-bar pull is proportional to the weight of the locomotive.

The speaker also gave a description of the mechanical construction, and an elementary outline of the theory of the motor and locomotive.

The second speaker was C. C. Behney, '08, Mem.Am.Soc. M.E., who discussed Pitot Tubes and Measurements. Mr. Behney explained the principal features of the various Pitot tubes in present use, illustrating his talk by blackboard sketches. The following principal conditions of construction are necessary: Tubes must be built to measure the flow in pipes of liquids and gases; to measure low as well as high velocities; to measure the flow in the open channel as well as in pipes, and they should be compact, light and strong, and easy to manipulate. The method of finding the pipe coefficient, the use of a recorder, and the float idea for measuring the flow of water, were explained. The speaker closed his lecture by a discussion of various types of meters for measuring water.

LELAND STANFORD JR. UNIVERSITY

At a meeting of the Leland Stanford Jr. University Student Branch on February 9, two papers were read. The first paper was presented by E. O. Bennett on The Gyroscopic Effect of Rotary Motors on Aeroplanes. The speaker first gave a description and explanation of the several different types of rotary motors, then a mathematical analysis of the forces which come into action and the methods of calculating rudder areas sufficient to overcome the gyroscopic forces. In the discussion, the disadvantages of a rotary motor were brought out which showed the reasons why the practice of using automobile type of motors is now becoming common.

The other paper was by F. P. Andrews on the Use of Developments in Long Distance Wireless Telegraphy. Mr. Andrews gave a description of the modern wireless apparatus and then discussed the methods which have made possible communication over increased distances. The apparatus used in wireless telephony was also discussed and its present limitations pointed out.

LOUISIANA STATE UNIVERSITY

The first regular meeting of the Student Branch of Louisiana State University was held on March 9, at which the constitution which had been drafted by a special committee was presented and accepted.

On March 10, a special meeting was held at which J. J. Munson delivered a lecture on Water Power and Pelton Water Wheels. Mr. Munson gave a few brief historical notes on the development of water power and described the resources of water power in the United States in comparison with the resources in other countries.

PENNSYLVANIA STATE COLLEGE

At a meeting of the Pennsylvania State College Student Branch on February 23, Dean R. L. Sackett, Mem.Am.Soc. M.E. and of the School of Engineering, gave a very interesting and instructive talk on Factors Governing the Revision of Factory Systems, and discussed fully the problems which arise in this work.

POLYTECHNIC INSTITUTE OF BROOKLYN

A meeting of the Polytechnic Institute of Brooklyn Student Branch was held on March 4, at which a talk on The Army Rifle was given by Leon Eben and Abbott Obendorfer, illustrated by pictures and slides showing camp life at Plattsburg camp last summer. They said that the "Springfield 1903" model rifle in general use in the U. S. Army and National Guard is an improvement on the Krag-Jorgensen rifle in that it is more accurate, more powerful and weighs only nine pounds. Its muzzle velocity is 2700 ft. per sec. and when the shell is fired, it exerts a pressure of 6500 lb. per sq. in. The rifling or grooving of the barrel, which gives the projectile a rotary motion and a high muzzle velocity, is a spiral of 10 in. pitch. The barrel is 24 in. in length and has therefore 2.4 turns throughout its length. The bayonet for this model weighs one pound, is 16 in. long, and can be locked into place, thus preventing its loss.

STATE UNIVERSITY OF IOWA

A meeting of the State University of Iowa Student Branch was held on February 19, at which an illustrated lecture on West Point was given by Prof. F. G. Higbee, head of the

Department of Descriptive Geometry and Drawing. Prof. Higbee began with a brief history of West Point from the time of its founding as a fort for defense up to the present time. With the aid of lantern slides, he gave a detailed account of the methods of instruction and discipline at the Academy. Much emphasis is laid on the classroom work; a record is kept of each student's recitation in every subject every day, and the average of the week's work determines the standing of each man for the following week. This method of grading is necessary as the positions awarded after graduation are based largely on the standing of the men in their class and military work as undergraduates. Prof. Higbee explained the system by which the work is interchanged with recreation and pointed out that the life of a cadet is not the grind and drudgery it is generally thought to be.

SYRACUSE UNIVERSITY

At a meeting of the Syracuse University Student Branch, F. M. Williams, '97, state engineer and surveyor for New York, gave an interesting history of the barge canal, illustrated by stereopticon views and moving pictures. Mr. Williams stated that the barge canal is the most extensive engineering feat ever attempted by an individual state. The Erie Canal was opened in 1825 and proved so successful that an immediate enlargement was proposed. At various times extensions have been made and when it is finally completed the Erie Canal will have a total length of 341 miles, including 161 miles of natural river bed, 157 miles of channelized river, and 22.6 miles of lake system.

The problem of rebuilding 280 bridges is the greatest obstacle which has arisen in the present work. Eighty of these are railroad bridges and a great deal of trouble has come up between the state and the railway companies. The work on the entrance to the harbor at Syracuse on Onondaga Lake has been hindered because of such difficulties.

Although the work was begun in 1905, there still remain serious obstacles. The harbors at Syracuse, Rochester and Tonawanda present some of the greatest difficulties yet met with. Machinery valued at $40,000,000 is in use on the canal and there is a greater variety of machinery than in any other engineering project today, not even omitting the Panama Canal. There are two methods of excavating rock under water; by means of the drill and derrick boat, and by a rock dredger. The latter performs its work by smashing the rock with a heavy hammer and then dredging it out. The hydraulic dredge has proved the most successful on the barge canal and less costly. This dredge excavates about 400,000 cubic yards per month. The work on the canal between Buffalo and Rochester had to be done in winter to avoid blocking navigation as the present course and the old one are very close together.

The syphon lock at Oswego is the only one of its kind in America and the largest in the world. A model of this lock won the grand prize at the World's Fair. The rise from the level of the Hudson to the Mohawk, a height of 169 ft., has been accomplished by means of five locks, extending over a distance of one and one-half miles. These locks are unequaled in the world.

The stereopticon and moving picture views showed the various workings of the canal. Among the features of interest shown by the pictures were the Lockport locks, Crescent dam on the Mohawk, the Syphon lock at Oswego, a large hydraulic dredge in operation, and a ladder dredge. The last film exhibited showed views taken by the Pathé Company to be used in their picture "Seeing America First."

THROOP COLLEGE OF TECHNOLOGY

A meeting of the Student Branch of Throop College of Technology was held on February 11, at which Ford W. Harris, Mem.Am.Soc.M.E., spoke on Patents. He explained the fundamental idea of a patent, which is a contract between the Government and a person by which the Government gives that person the sole right to make, use, and sell his article or process, in consideration for which the person makes known a new invention or process. Mr. Harris explained the patent laws of this country and compared them with those of foreign countries.

UNIVERSITY OF ARKANSAS

On February 29, the University of Arkansas Student Branch of the Am.Soc.M.E. and of the A.I.E.E. held a joint meeting, at which Prof. B. N. Wilson, Mem.Am.Soc.M.E., presented an address on Scientific Management. He gave a brief history of scientific management and illustrated by several examples that it could be applied to almost every kind of industry. Professor Wilson pointed out that although the installation of such a system costs a great deal, it is cheaper in the end.

Prof. H. A. Brown of the electrical engineering department gave a demonstration of the wireless telegraph and explained by blackboard sketches its theory and working principles.

UNIVERSITY OF CALIFORNIA

The University of California Student Branch held its second meeting of the semester on February 22. H. S. Bean presented a paper entitled Rate Setting in Machine Shops, C. Sebastian discussed his thesis on Tests of the Starrett Compressed Air Pump, and E. Eichler gave a paper on High Explosive and Shrapnel Shell Manufacture.

At a meeting of the Branch on March 7, H. Crow presented a paper on The Gas Turbine. He discussed both the theoretical and practical phases of the subject and supplemented his discussion with slides showing various types of gas turbines. Prof. R. S. Tour discussed the "Relativity Theory" and touched upon some of the many deductions which may be made by the application of this theory. The subject of Oxy-Acetylene Welding was presented by C. V. Foulds, who reviewed the various methods employed and the application of this form of welding, and concluded by giving a practical demonstration of welding.

UNIVERSITY OF CINCINNATI

At a meeting of the University of Cincinnati Student Branch on February 3, A. J. Baker, Mem.Am.Soc.M.E., spoke on The Opportunities and Field of the Engineer. Mr. Baker said that there is no profession which does more in the service of humanity or that demands that a man know his business thoroughly and be honest than the engineering profession, yet most people know very little about the engineer's work. It is the duty of every engineer to strive to correct the poor conception of the people and to endeavor to establish a higher plane for the profession, by widening the field of activity and developing the fields already entered.

The speaker mentioned some of the new fields to which the engineer might well direct his energies, among them the wind motor, the use of machinery for harvesting, and the development of sun machinery. He also emphasized water power development, and said that the work of controlling floods, such as the floods in the Mississippi Valley, and keeping the surface land on the farms is a field of activity well worth the endeavor of the engineer.

In closing, Mr. Baker spoke of the growing demand for machines which require mental effort to operate, instead of the machines so generally built at the present time which are made as automatic as possible in order that they may be operated by anyone with little or no mental effort, and pointed out that in the development of machinery along more efficient lines lay another great field for the engineer.

A joint meeting of the Student Branch of the Am.Soc.M.E. and A.I.E.E. was held on March 2. Dr. J. D. Magee of the Department of Economics gave a short address on Engineering Economics. After the address, a social was held in charge of the Seniors of the electrical engineerig department.

UNIVERSITY OF COLORADO

The University of Colorado Student Branch held a meeting on February 17, at which Harold Worcester read a paper, illustrated by slides, prepared by C. H. Thomas of the Skinner Engine Company. The paper took up history and origin of the uniflow engine, its principle of operation, construction, and valve action; special attention being given to the effect of the auxiliary exhaust valve in reducing the final compression pressure and clearance volume, a result which has made

this type of engine practical for noncondensing, medium pressure work.

UNIVERSITY OF KENTUCKY

At the regular February meeting of the University of Kentucky Student Branch the paper on Analysis of the Cylinder Performance of Reciprocating Engines, by J. Paul Clayton, Mem. Am.Soc.M.E. and of the University of Illinois, was discussed. G. L. Cherry introduced the subject with a twenty minute talk which was followed by a mathematical treatment of the subject by J. Wolf. A theoretical discussion was then given by Prof. Cassidy and a practical discussion by Prof. Wilhoite.

The Branch plans to spend the week of March 20 in Chicago and vicinity, inspecting the various points of engineering interest there.

UNIVERSITY OF MINNESOTA

An open meeting of the Minnesota Student Branch was held on February 19. At this meeting, moving pictures were shown illustrating the process of Thermit Welding. G. A. Ek, president of the Branch, explained the details of this process of welding.

On February 24, the Branch held its second annual get-together in the Auditorium. The principal speaker was Paul Doty, Mem.Am.Soc.M.E. and vice-president and general manager of the St. Paul Gas Light Company, who spoke of the engineer and engineering of the present time. Short talks were given by Prof. J. J. Flather, head of the mechanical engineering department, and Prof. W. H. Kavanaugh, head of the experimental engineering department.

The regular monthly meeting of the Student Branch was held March 4, at which A. P. Mason, a member of the senior mechanical engineering class, read a paper on the History and Use of Milling Machines. He illustrated his article by slides furnished by the Brown and Sharpe Manufacturing Company.

UNIVERSITY OF MISSOURI

A meeting of the Student Branch of the University of Missouri was held on February 21. The first speaker was Prof. A. L. Westcott, Mem.Am.Soc.M.E. and formerly assistant professor of mechanical engineering in the university, now superintendent of buildings, who spoke on the Advantages to the Student of Membership in the A.S.M.E. Student Branch. He pointed out the benefits to be gained by the student through the regular meetings of the section, and the chances to hear and take part in the programs.

J. W. Haney, Mem.Am.Soc.M.E., addressed the students on The Operation of the Power Plant and Heating-Ventilating System of a Large Office Building. He based his remarks mostly on his own work as chief engineer of the Commerce Power Company in connection with the Commerce Building at Kansas City, Mo., and told of many interesting things which happened in the operation of the plant, especially in connection with the elevator service.

An election of officers for the second semester 1915-16 was held, the following men being elected: Fred P. Hutchison, president; L. Seuter, corresponding secretary; R. B. Warren, secretary-treasurer; J. W. Haney, R. M. Loetz, F. Nelson Westcott, governing board.

WORCESTER POLYTECHNIC INSTITUTE

At a meeting of the Worcester Polytechnic Institute Student Branch on March 3, Frank H. Trego, chief engineer of the Knox Motor Company, Springfield, Mass., and formerly research engineer for the Packard Company, gave an interesting talk on Automobile Engineering, dealing particularly with the details of construction and design, and explaining many problems which have arisen in the manufacture of motors. The speaker first considered the crank case or foundation of the motor, mentioning the advantages which aluminum possesses because of its light weight, and the disadvantages of excessive warping. A lengthy discussion was given regarding the advantages and disadvantages of two, three, four, and seven bearing crank shafts, particular emphasis being placed on the necessity for proper lubrication of these bearings. In explaining the importance of quiet running of automobile mechanism, Mr. Trego said that most purchasers care more about the details of appearance, quiet running and body construction than about the performance of the motor. He then discussed some of the causes for noise in gear trains, such as interference, poor alignment, improper material and poor lubrication, and their remedies, also the construction of the connecting rod and the broaching of bearing holes, and mentioned the offset piston pin and the elimination by this means of "piston slap." Mr. Trego showed several photographs of a modern aeroplane motor and explained its construction.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, and is pleased to receive requests both for positions and for men. Copy for the Bulletin must be in hand before the 18th of the month. The notices now appear in the Employment Bulletin in a form which indicates the classification.

POSITIONS AVAILABLE

The Society acts only as a "clearing house" in these matters and is not responsible where firms do not answer. Stamps should be enclosed for forwarding applications.

69 Technical Graduate to take charge of mechanical department of company building oil well machinery, employing about seventy-five men in thoroughly well-equipped and up-to-date plant. Salary $1800 to $2500 with good opportunity for advancement for progressive man. Location Texas.

116 Superintendent or Overseer to take charge of the mechanical side of manufacture of special line of chemicals used in fabric manufacturing concern. Location, New England.

120 Instructors for large Eastern college. Three instructors to combine teaching of shop work with practice of applied principles of scientific management. Instructor (a) wood-working; (b) forging; (c) machine shop and partly on thesis and factory layout work. Applicants must be graduates of an engineering college, and must be willing to adapt themselves to prescribed methods and begin at as low a salary as $1000 to $1100.

122 Heating and Ventilating Engineer, young technical graduate, with three or four years experience in this line of work. Location, Ohio.

124 Assistant to Plant Engineer young technical graduate, with about one year of practical experience, for work in plant maintenance, to include design, drafting, testing and investigations. Salary $65 to $75 a month with good opportunity for advancement.

125 Tool Designers, American or English. Location, Pennsylvania.

130 Textile Plant Engineer, one capable of studying textile operations with view to making improvements in machines or processes; who has had experience in similar lines, or a practical designer in connection with textile machinery. Salary $2000 to $3000, dependent upon ability and experience. Location, New England.

135 Draftsman, construction and equipment of sugar factories. Location, New York.

137 Manager, experienced in machine shop engine business; preferably one who can make investment and thus secure greater interest in business, for New Jersey concern, manufacturing steam and gas engines.

138 Research Assistant, young engineer to work principally along line of tests. Location, New Jersey.

139 Young Engineer Designer, with technical education and special training in the design of automatic machinery for the manufacture of small interchangeable parts; excellent chance for advancement to one who displays ability and application. Location, Chicago.

141 Assistant Superintendent with practical pattern shop, foundry and machine shop experience; technically educated man is preferred, who is ingenious and resourceful enough to handle the details of developing manufacturing methods in a shop turning out a large variety of machines in comparatively small numbers. Location, Middle West. Apply by letter.

146 Mechanical Engineer, splendid opening for young graduate of technical school, specialist in machine tool work; should be able to negotiate with manufacturers for agencies and demonstrate their products. Includes six to nine months' travel each year in Europe. In replying, state age, experience, salary expected, when at liberty, etc.

147 Assistant to Chief Engineer; all-around mechanical engineer wanted for assistant to chief engineer of firm doing large foreign business; would be in charge when chief is in Europe. Good opportunity for well educated technical graduate with right experience. State age, salary expected, previous experience, and when at liberty. Location, Massachusetts.

149 Chief Engineer with experience in chemical industries, for important new branch of established dye stuff factory. Location, Eastern States. Apply by letter giving details of experience and salary expected.

151 Manufacturing Executive to develop manufacture of addressing, folding and wrapping machines for newspapers and books. Must know paper handling and paper folding machinery and be able to design practical tools and jigs for manufacturing this particular product; should be thoroughly familiar with purchasing, clerical and accounting work in connection with factory, including stock-keeping, inventory taking, production ordering, etc. Growing opportunity; salary to start about $2500. Location, Middle West.

156 Sales Engineer thoroughly versed in the industrial hydraulic machinery line, competent to look after local interests of company. Location Middle West.

157 Designer and Draftsman as Assistant to engineer of concern manufacturing industrial hydraulic machinery. Location Middle West.

159 Production Engineer: A plant in Central New York State, manufacturing small arms, both sporting and military, of high reputation, requires a young mechanical engineer to standardize product and manufacturing processes for economical production of accurately interchangeable parts; must have high grade machine shop experience with arrangement of equipment, manufacturing operations, means for handling and storing materials, and in making operation studies to set production rates. Salary dependent on qualifications.

160 Production Engineer: A plant in Western Pennsylvania, making automobile frames and drop forgings for automobile parts and machining the latter, requires the services of a young mechanical engineer, familiar with similar work, to take charge of routing and scheduling work throughout the plant. Salary dependent on qualifications.

165 Chief Inspector, for a plant in Central New York State manufacturing small arms, both sporting and military, of high reputation. Must be mature man with experience on high grade machine work.

172 Superintendent, unusual opportunity with well established growing machine building concern; high-class executive up-to-date in shop practice. Location Brooklyn. State experience, age, and salary.

173 Instructor in Mechanical Engineering for university in California; to assist in steam, hydraulics and testing materials laboratories, and possible charge of a section of applied mechanics. Salary $1000 or less depending on man; young man with one or two years experience either in teaching or practical work.

174 Assistant Superintendent in forge department; general requirements are knowledge of oil furnaces and some experience in hydraulic forge work. Salary approximately $150 a month.

175 Draftsman for Connecticut concern of manufacturing chemists. Salary $20 to $30.

178 Chief Draftsman on oil well machinery; good opportunity for right man; would eventually require residence in Texas.

179 Draftsman experienced in elevating and conveying machinery and light structural work; preference given to man who would develop into salesman. Salary $1500 to $1700. Apply by letter with object of personal interview. Location New York State.

MEN AVAILABLE

The published notices of "men available" are made up only from members of the Society. Notices are not repeated in consecutive issues of the Bulletin. Names and records are kept on the office list three months, and at the end of such period if desired must be renewed.

Members sending in notices for the Men Available section are particularly requested in the future to indicate the classification under which they desire their notices to appear.

D-118 Student Member, one year's experience, record good, reference upon application. Graduate in mechanical engineering course in June, desires opportunity for advancement with manufacturing concern.

D-119 Member; age 31. M.I.T. Has had diversified engineering training, also five years selling experience. Experienced in the design and application of mechanical conveyors for industrial plants. Wants position preferably with automobile manufacturer. Salary $2500. Answer through the Society.

D-120 Assistant to Executive Officer, large manufacturing corporation to promote unity of organization, economy and efficiency. Object, establishment of a permanent connection leading to greater responsibility and remuneration through years of service. Technical graduate, 31, experience in economy and efficiency work as member of staff of noted efficiency engineer, as assistant to comptroller, as manager of manufacturing plant, and as investigator of costs and statistics for one of largest industrial corporations in this country.

D-121 Efficiency or Factory Manager, technical graduate, M.E., age 30, ten years experience in costs, statistics, production work, office and factory management, references to several successful concerns for ability and results obtained as an organizer.

D-122 District Office Manager or Assistant to general sales manager, or manufacturer's representative handling several non-conflicting lines; would consider partnership in established selling or equipment company. Experience in selling and engineering work in eastern territory, graduate mechanical engineer, age 35, married, experience covering a wide range of industries; highest references as to character and ability.

D-123 Publicity and Sales Engineer, 20 years experience, bookkeeper, accountant, salesman, department manager, assistant factory manager, advertising manager, assistant sales manager, knowledge of the country from Maine to Cuba and from Atlantic to the western coast. Accustomed to large production and sales problems.

D-124 CHIEF DRAFTSMAN or ASSISTANT MECHANICAL ENGINEER, college graduate, experienced designer, machinery, structural iron and small automatic machines.

D-125 POWER PLANT ENGINEER, experienced in design, heating and ventilating, industrial plants; selling experience; wishes responsible position. Has had charge of men and shown executive ability.

D-126 SUPERINTENDENT and MECHANICAL ENGINEER, ten years experience on construction work, in charge of design, erection and operation of equipment, buildings and power plants for firm of consulting engineers. Twelve years previous experience in machine shops and in charge of steam plants; desires position with construction or manufacturing firm.

D-127 MECHANICAL or CHIEF ENGINEER, age 31, four years experience as superintendent of erection and chief operating engineer of large power and industrial plants; four years in charge of design and detailing of power plants; good executive ability, capable of assuming any responsibility in power plant lines and getting results from factory organization. Location preferred in U. S. A. Salary $2500.

D-128 SUPERINTENDENT or MASTER MECHANIC, American, age 33, practical tool-maker and machinist, at present employed as master mechanic in factory employing about 600 hands, experienced in sheet metal stamping and automatic machinery on interchangeable manufacturing, estimating, design of machinery and tools, an all-around production man of experience who can effect results. Answers to this notice treated confidentially.

D-129 STEEL ENGINEER, member, technical graduate, age 30, ten years experience in treating, testing and micro-structure of steel; practical knowledge of the treatment of steels to obtain best physical and machining properties; capable of eliminating all troubles in the working of steel and manufacture of steel products.

D-130 ELECTRICAL and MECHANICAL ENGINEER, Cornell graduate with extensive experience designing, constructing, operating, maintaining, purchasing, managing and office engineering, desires position where such experience would be required. Now chief electrical and mechanical engineer, constructing and operating an explosive plant. Engineering work of operation of minor importance reason for change.

D-131 MANAGER, MECHANICAL AND MARINE ENGINEER, designer; associate member, college graduate, age 36, married, American citizen, speaks English, French, Italian, Spanish, some knowledge of German. Three years practical experience as a marine engineer. Six years a district manager of an electric illuminating and manufacturing company. Six years experience in mechanical design of electrical machines with two leading American manufacturing concerns; expert calculating engineer. At present employed; four years in present position; open for engagement in U. S. or abroad. New York City preferred.

D-132 SUPERINTENDENT OF POWER desires change. Chief engineer of power two years in large mining and smelting works in South America. Worked as erector in smelters of Arizona installing engines and blowers. Superintendent of electric light and water for municipality. Consulting engineer own office in Texas two years; engineering construction in Mexico at time of Madero's overthrow; past two years and at present doing engineering sales work power plant and pumping machinery. Member A.M.S.E. and Louisiana Engineering Society.

D-133 PLANT ENGINEER or MASTER MECHANIC, age 36, complete mechanical, electrical, buildings equipment; land or water front properties; maintenance and extensions; extensive practical and office experience. Desires change; connection with industrial or engineering concern.

D-134 CHIEF, MECHANICAL or CONSULTING ENGINEER. Associate; technical education; fourteen years experience, familiar with designing industrial plants, mill buildings, ore roasting furnaces, coal washing, screening, elevating and conveying machinery, having held positions as chief draftsman, engineer or construction and chief engineer for large concerns.

D-135 CHIEF DRAFTSMAN or ASSISTANT CHIEF ENGINEER, Cornell graduate, 15 years varied experience with engineers and contractors and industrial concerns doing their own plant engineering and with manufacturing concerns. Experience principally in drafting room and engineering office.

D-136 MECHANICAL and ELECTRICAL ENGINEER, Cornell gradute, age 31, with nine years experience in the design, construction, operation and testing of steam and electric power and pumping stations, also sewage disposal works, desires position with consulting engineer, manufacturer of power plant apparatus, construction, or operating company.

D-137 SAFETY ENGINEER or INSPECTOR. Junior member, age 26, single; $2\frac{1}{2}$ years experience in safety work, 1 year as assistant safety engineer in a large metallurgical plant employing over 5000 men. Experience in first-aid instruction and organization of safety committees. Over 4 years experience in general drafting. Location immaterial. At present employed, but available on short notice.

D-138 INSTRUCTOR IN MECHANICAL ENGINEERING. Junior member, technical graduate, age twenty-six, married; experience as assistant superintendent of manufacturing, with illuminating gas company in charge of labor and mechanical equipment; six months in a drafting room; two years successful teaching experience; employed until July first; desires position with a college or university beginning in September, 1916.

D-139 Student member of University of Kentucky; mechanical and electrical engineering department; would like opportunity to go to South or Central America on graduation in June. References.

D-140 MANAGER or SUPERINTENDENT. Mechanical engineer, technical graduate, ten years experience, design and construction centrifugal pumps and pumping engines. Employed but available on short notice.

D-141 TOOL or SPECIAL MACHINE DESIGNER; associate member, graduate in machine design, age 32, married; 5 years experience as chief draftsman, desires opportunity at tool design or special machinery design; immediately available. Location New York.

D-142 CHIEF ENGINEER or SUPERINTENDENT of power plant, with 12 years experience in present power plant practice, refrigeration, steam heating and gas, desires position with large corporation or power company with an opportunity to show results. Salary to start $2400. At present employed.

D-143 ASSISTANT to CONSULTING or MECHANICAL ENGINEER. Graduate M.E., age 26, experience in responsible charge of installation, and plans for factory machinery layouts, power transmission systems, foundations and piping layouts for power plant equipment and accessories, mechanical equipment of buildings. Location in central states preferred. At present employed.

D-144 EXECUTIVE wishes to make permanent connection with manufacturer of electrical machinery. Practical experience of sixteen years includes drafting, testing, designing and manufacturing, also sales and general management; responsible charge of entire business for considerable time. Would take charge of branch office, but preference given to factory position.

D-145 INSTRUCTOR or ASSISTANT PROFESSOR; young engineer, at present in charge of the courses in engineering laboratory in prominent eastern university, seven years widely varying experience teaching nearly all branches of mechanical engineering, and about four years practical experience in drafting room and shop, desires position in a college receiving state support, east or middle west preferred. Will furnish best of references and adequate reasons for desiring change.

D-146 WOOD-WORKING. Junior member wishes a position in a wood-working shop.

D-147 PRODUCTION ENGINEER. Associate member, 32, specialist in interchangeable manufacturing. Broad experience in

machine shop, foundry, stamping, shaping, plating and finishing. Record for stability and successful manufacturing. Past four years works manager. Vicinity New York. Salary $3800. Highest credentials.

D-148 Designer, Test Engineer or Assistant to Consulting Engineer in industrial or power plant work. Mechanical engineer, age 27, three years machine shop experience, two years power plant design, two years power plant testing.

D-149 Estimator desires executive position, several years varied experience, can present best testimonials; 30 years old, speaks foreign languages.

D-150 Superintendent and Mechanical Engineer, technical graduate, fifteen years experience as executive in charge of building and power plant construction, including layouts, purchase, installation and operation of complete mechanical equipments. At present employed by large corporation as engineer in charge, desires similar position.

D-151 Manufacturing Executive. Associate member, technical graduate, six years manufacturing and designing experience.

D-152 Student member, age 23, desires employment at a moderate salary, where advancement is possible. Will graduate from university in June.

D-153 Sales Engineer, Chief Engineer, Manager, Superintendent: Cornell graduate in mechanical engineering, age 36. Broad experience in general engineering both from a technical and practical standpoint. Particularly familiar with the design, manufacture, erection, operation and development of hoisting, conveying and handling machinery and plants. Experienced in structural design. Employed for the past ten years by a leading concern but seeks opening for advancement.

D-154 Mechanical and Combustion Engineer. Junior member, age 25, married, technical graduate, four years power plant experience, including design, tests, and operation, specializing on fuel and power plant economies. At present employed, desires position along above lines offering attractive opportunity for the future.

D-155 Manager of Sales, 42, aggressive and efficient; desires to make connection with concern wishing to develop its business along broad lines; now vice-president and general manager of an engineering concern; desires change for reasons satisfactorily explained; technical and practical training, with broad experience in selling in the field. Successful record with ability to produce results. Valuable acquaintance with consulting and operating engineers and industrial concerns.

D-156 Hydraulic and Mechanical Engineer; technical graduate, speaks and corresponds fluently in three languages. Fifteen years experience in designing, manufacturing and operating hydraulic turbines, centrifugal pumps, hydro-electric power plants; also mechanical equipments for mines. Well acquainted with leading business institutions and consulting engineers in Canada, United States and Mexico also first class foreign relations in Britain and European Continent. At present employed in executive capacity but desires change. Can furnish high class references.

D-157 Teacher, technical graduate with ten years experience, including practical work and teaching, desires a position in the mechanical engineering department of a university or technical school.

D-158 Chief Engineer, Superintendent or Equipment Engineer of manufacturing methods, exceptionally well educated, trained and experienced, technical graduate 1904; varied experience as machinist, tool and die maker, tool department sub-foreman, foreman, tool and machine designer and inspector, acting equipment engineer, production superintendent. Acquired skill and the reputation of an expert, speaks several languages, thoroughly able to handle and teach men. Excellent references.

D-159 Engineer, with private firm or consulting engineer, technical graduate, age 34, twelve years experience in design, testing, supervision and reports on light, heat and power plants; specialized in economical power production.

D-160 Engineer Assistant to Executive. Member, technical graduate, wide experience in management, sales, operating and executive work; at present engaged; desires position capable of being developed to broad future.

ACCESSIONS TO THE LIBRARY

A List of Books and Pamphlets Added During the Past Month to the Library of the Society and of the United Engineering Society, Engineering Societies Building, New York

ADDITIONS BY THE SOCIETY

This list includes only accessions to the library of this Society. Lists of accessions to the libraries of the A.I.E.E. and A.I.M.E. can be secured on request from Calvin W. Rice, Secretary of Am. Soc. M. E.

American Society of Swedish Engineers. Bulletin vols. 8 and 9. *Brooklyn, 1914-15.* Gift of Society.

Association of Railway Electrical Engineers. Proceedings vol. 6, 1913. *Chicago, 1913.* Gift of Association.

Building Construction as Affecting Fire Risks, C. F. Wieland. *San Francisco, 1915.* Gift of author.

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. Extract from Yearbook no. 14, 1915. Gift of Institution.

Coxe, Arthur Cleveland, Memorial. Class of 1897. Hobart College. Gift of Hobart College.

Detroit Board of Water Commissioners. 63rd. Annual Report. *Detroit, 1916.* Gift of Detroit Water Department.

Insuring the Coal Supply, Henry J. Edsall. Reprint Coal Age, Nov. 6, 1915. Gift of Link Belt Company, Chicago, Ill.

New York City Board of Water Supply. Information for bidders, for furnishing and delivering bronze gate valves for the City Tunnel of the Catskill Aqueduct. 1916. Contract 172.

——— Information for bidders for lining with brick masonry a portion of the Eastview Tunnel of the Catskill Aqueduct. 1916. Contract 169. Gift of Board of Water Supply, New York City.

New York State Engineer and Surveyor. Annual Report. Supplement. Vol. II, 1914. *Albany, 1915.* Gift of State Engineer and Surveyor.

North Dakota Society of Engineers. Proceedings vol. 2. 1915. *1915.* Gift of Society.

Russian Department of Agriculture. Bulletin of the Bureau of Farm Mechanics. Vol. VII, part IV. *1915.* Gift of Russian Department of Agriculture.

The Settlement of the Most Important Question of the Age: Is the Efficiency of a Thermodynamic Reversible Cycle Independent of the Working Medium? By Jacob T. Wainwright. *Chicago, 1915.* Gift of author.

Society for the Promotion of Engineering Education. Proceedings vol. XXII. *Pittsburg, 1915.* Gift of Society.

New Bedford, Water Board. Report, 1915. *New Bedford, 1916.* Gift of Water Board of New Bedford.

Society of Constructors of Federal Buildings. List of Members. *February, 1916.* Gift of Society.

Worcester, City of Prosperity. 16th Annual Convention National Metal Trades Association. April, 20-22, 1914, by Donald Tulloch. *Worcester, 1914.* Gift of P. E. Barbour.

GIFT OF HOWARD E. CORNELL

Letters Patent issued in 1841 to Ebenezer Beard, signed by Daniel Webster, "On Screw Propellers." Issued in 1853 to Ebenezer Beard, covering "Improvement in Propellers" and assignment of same to Messrs. Reaney, Neafie & Co.

TRADE CATALOGUES

Brown Hoisting Machinery Co. *Cleveland, O.* Catalogue D. Brownhoist Tramrail Systems Trolleys, Electric Hoists. *1915.*

Stephens-Adamson Mfg. Co. *Aurora, Ill.* Labor Saver. *Feb. 1916.*

Texas Company. *New York, N. Y.* Lubrication. *Feb. 1916.*

Valley Iron Works Co. *Appleton, Wis.* The Beater. *Jan.-Feb. 1916.*

Walworth Manufacturing Co. *Boston, Mass.* Catalogue No. 74. 486 pp. Walworth Log. *Feb. 1916.*

Wiedeke, Gustav & Co. *Dayton, Ohio.* Ideal Catalogue No. 48. Ideal Tube Expander and Cutter.

Warner Elevator Manufacturing Co. *Cincinnati, Ohio.* Bulletin 2701. "Type N" Freight Cars, Jan. 1916. Bulletin 2702, "Type M" Steel Freight Cars, Jan. 1916. Bulletin 2802, No. 11 Electric Elevator, Jan. 1916. How to Obtain the Best Service at the Least Cost.

ADDITIONS BY THE UNITED ENGINEERING SOCIETY

Aeronautische Meteorologie, Franz Linke, part 1-2. Luftfahrzeugbau und Führung, Neumann, Band I, II. *Frankfort, 1911.*

Aéroplanes and Dirigibles of War, F. A. Talbot. *Philadelphia, 1915.*

American Army, W. H. Carter. *Indianapolis, 1915.*

Annals of a Fortress, E. Viollet-le Duc. Translated by Benjamin Bucknall. *London, 1875.*

Applied Thermodynamics for Engineers, W. D. Ennis. Ed. 4. *New York, 1915.*

Architects' and Builders' Pocket Book, by the late F. E. Kidder. ed. 16. *New York, J. Wiley & Sons, 1916.* Gift of Publisher. Price $5.00 net.

The book has been entirely revised, and is in many respects a new work, being entirely reset, in a smaller but clearer type. Much new matter has been added. The amount of information condensed into the 1800 pages is very great. W. P. C.

Armor and Ships, J. W. Gulick. *Fort Monroe, 1910.*

Attack of Fortified Places, Including Siege Works, Mining and Demolitions, James Mercur. *New York, 1914.*

Die Automobil-Betriebsstoffe, Ernst Jaenichen. *Berlin, 1915.*

Beihefte Zum Gesundheits Ingenieur, K. Brabee. Beiheft 8. *Munchen, 1915.*

Wie berechnet, konstruiert und baut man ein Flugzeug, O. L. Skopik. ed. 2. *Berlin, 1915.*

British Columbia Bureau of Mines. Preliminary review and estimate of Mineral Production, 1915. Bulletin No. 1, 1915. *Victoria, 1916.*

Building Estimator's Reference Book, F. R. Walker. *Chicago, 1915.*

Canada Department of Mines. Summary Report of the Mines Branch, 1914. *Ottawa, 1915.*

——— Production of Cement, Lime, Clay products, stone and other structural materials in Canada, 1914. *Ottawa, 1915.*

Canons of Classification, W. C. B. Sayers. *London, 1915-16. White Plains, N. Y.*

Carnegie Library of Pittsburgh. Road Dust Preventives, references to books and magazine articles. *Pittsburgh, 1916.*

Cold Storage and Ice Association. Proceedings vol. XII, 1915. *London, 1915.*

Colorado Industrial Plan, John D. Rockefeller, Jr. Including a copy of the plan of representation and agreement adopted at the coal and iron mines of the Colorado Fuel and Iron Co. *1916.* Gift of John D. Rockefeller, Jr.

Contributions to the Pre-Cambrian Geology of Northern Michigan and Wisconsin. Michigan Geological & Biological Survey. Publication 18. *Lansing, 1915.*

Cornell University. Librarian's Report, 1914-15. *Ithaca, 1915.*

Description of the Laboratories of the Mines Branch of the Department of Mines. Canada Mines Branch, Bulletin no. 13. *Ottawa, 1916.*

Designing, Heating and Ventilating Systems, Chas. A. Fuller. *New York, 1914.*

Digest of Workmen's Compensation Laws, 1913. *New York, 1913.* Gift of National Association of Manufacturers.

The Einasleigh Freehold Copper Mine, N. Q. Publication no. 246, Queensland Geological Survey. *Brisbane, 1914.*

Elementary Naval Tactics, Wm. Bainbridge-Hoff. *New York, 1907.*

Employers' Liability, Workmen's Compensation and Prevention of Work Accidents, F. C. Scherdtman. *1912.* Gift of National Association of Manufacturers.

Enzyklopadie der technischen Chemie, Fritz Ullmann. Band 3. *Berlin, 1916.*

Erlauterungen zu Normalien fur isolierte Leitungen in Starkstromanlagen, den Normalien fur isolierte Leitungen in Fernmeldeanlagen sowie den Kupfernormalien, Richard Apt. *Berlin, 1915.*

Esplodenti e Modo di Fabbricarli, R. Molina. *Milano, 1916.*

Geology and Mineral Resources of the Stanthorpe, Ballandean and Wallangarra Districts, Southern Queensland, 1913. Publication no. 243, Queensland Geological Survey. *Brisbane, 1914.*

Graphics and Structural Design, H. D. Hess. ed. 2. *New York, J. Wiley & Sons, 1915.* Gift of publisher.

A number of changes have been made, including a more extended treatment of steel mill buildings and of reinforced concrete, modifications and explanations of the specifications, and other changes due to advances made in the subject. W. P. C.

Handbook for Light Artillery, A. B. Dyer. *New York, 1908.*

Handbook of Natural Gas, H. P. Westcott. ed. 2. *Erie, Pa., 1915.*

Handbook of Problems in Direct Fire, Jas. M. Ingalls. *New York, 1903.*

Handbuch der Eisen und Stahlgiesserei, C. Geiger. Band II. *Berlin, 1916.*

Handbuch der Mineralchemie, C. Doelter. Band II, pt. 9. *Dresden, 1915.*

Handbuch fur den Deutschen Braunkohlenbergbau, G. Klein. ed. 2. Textband and Tafelband. *Halle, 1915.*

Die Hebezeuge, Hugo Bethmann. ed. 3. *Braunschweig, 1915.*

Hydraulic Motor, I. P. Church. *New York, 1914.*

Industrial Betterment Activities. Gift of National Association of Manufacturers.

Institute of Radio Engineers. Year Book, 1916. *New York, 1916.*

International Engineering Congress, 1915. Transactions. vol. VI-Mechanical Engineering. *San Francisco, 1915.*

Inventions and Patents, P. E. Edelman. *New York, 1915.*

Investigation of a Reported Discovery of Phosphate in Alberta, Canada. Mines Dept. Bulletin no. 12. *Ottawa, 1916.*

Konstruktionsberechnungen von Kraftfahrzeugen und die Organisation des Konstruktionsburos, A. G. von Loewe. *Berlin, 1915.*

Lehrbuch der Elektrochemie von Svante Arrhenius. *Leipzig, 1915.*

Leitfaden der drahtlosen Telegraphie fur die Luftfahrt, Max Dieckmann. *München, 1913.*

Machinists and Founders Supplement to Thomas' Register of American Manufacturers and First Hands. *New York, 1915.* Gift of Thomas Publishing Co.

Market System for New York City and Open Markets Established in Manhattan, Marcus M. Marks. *1915.* Gift of Author.

McGraw Electrical Directory. Railway Edition, February 1916. *New York, 1916.*

Metal Statistics, 1916. Ninth Annual Edition. *New York, American Metal Market Co., 1916.* Gift of publisher.

Mineral Resources of Michigan with statistical tables of production and value of mineral products for 1914 and prior years. Michigan Geological & Biological Survey. Publication 19. *Lansing, 1915.*

Moderne Seifenfabrikation, A. Ganswindt. *Leipzig, 1915.*

Motor and Carriage Painting, A. Bates. *London, 1915.*

New York Times Index, vol. IV, 1915. *New York, 1915.*

Die Nutzbaren Mineralien mit Ausnahme der Erze, Kalisalze, Kohlen und des Petroleums, Bruno Dammer und Oskar Tietze. Band II. *Stuttgart, 1914.*

Papierprufung, Wilhelm Herzberg. ed. 4. *Berlin, 1915.*

Pennsylvania. Mines Department. Report, 1914. Part I—Anthracite. *Harrisburg, 1915.*

Pennsylvania Workmen's Compensation Board. Rules and Rulings. *Harrisburg, 1916.*

Power for Profit, R. P. Bolton. *New York, 1915.*

300 Practical Shop Kinks. Gift of American Machinist.

Preliminary Report on the Mineral Production of Canada, 1915. *Ottawa, 1916.*

Preliminary Statement on the Mineral Production in the Province of Quebec, 1915. *Quebec, 1916.*

Quarry Materials of New York—Granite, Gneiss, trap and marble. N. Y. State Museum. Bulletin no. 181. *Albany, 1916.*

Railway Maintenance Engineering, with notes on Construction, W. H. Sellew. *New York, 1915.*

Raw Materials for the Enamel Industry and their chemical technology, Julius Grünwald, translated by Herbert H. Hodgson. *London, 1914.*

Scherzer Rolling Lift Bridges, their inception, development and Use. *New York-Chicago.* Gift of Scherzer Rolling Lift Bridge Co.

Seile und Ketten, F. Peter. Die Maschinen der Berg und Hüttenwerke, pt. 2. *Halle, 1914.*

Shafting, Pulleys, Belting, and Rope Transmission. Compiled by H. E. Collins. *New York, 1908.*

Smokeless powder, nitro-cellulose and theory of the cellulose molecule, J. B. Bernadou. *New York, 1908.*

Societe Technique de L'Industrie du Gaz en France. Compte Rendu 41me Congrès. *Paris, 1914.* Gift of Geo. G. Ramsdell.

Special Libraries. Cumulative Index, vol. 1-6, 1910-15. *Reading, Mass.*

Statistics of the Mineral Production of Alabama for 1914. Bulletin no. 16, Geological Survey of Alabama. *University, 1915.*

Surveyors Institution. Professional notes from their commencement in 1886-1913 (vols. 1-19), with General Index to vols. 1-17, 1886-1911. *London, 1886-1913.*

——— Transactions, 1868-1914 (vols. 1-46), with general index to vols. 1-42. *London, 1868-1914.*

Text Book on Field Fortification, G. J. Fieberger. ed. 3. *New York, 1913.*

Toy Making. A practical guide to the making of a number of popular toys. *London-New York, 1915.*

U. S. National Museum. Report, 1915. *Washington, 1916.*

University of California. Annual Report of the President 1914-15. *Berkeley, 1915.*

Die Verwendung von Pressluft im Bergbaubetriebe, A. E. Llwehr. *Weimar, 1915.*

West Virginia Geological Survey. Reports of Lewis and Gilmer Counties with Maps. *Wheeling, 1916.*

World Almanac and Encyclopedia, 1916. *New York, 1916.*

GIFT OF AERONAUTICAL SOCIETY

Aeronautical Classics, edited for the council of the Aëronautical Society of Great Britain by J. O. B. Hubbard and J. H. Ledeboer. *London, 1910-11.*

Ashton, W. G. Model Flying Machines, their design and construction. *London.*

Brockett, Paul. Bibliography of Aeronautics. *Washington, 1910.*

Collins, F. A. Second Boy's Book of Model Aeroplanes. *New York, 1911.*

Davis, C. H. National Old Trails road, ocean to ocean highway. *Washington, 1914.*

Flying, the why and wherefore by Aero Amateur. *London.*

Hering, D. W. Essentials of Physics for college students. *New York, 1912.*

L'Institut Aerodynamique de Koutchino. Bulletin Fascicule I. ed. 2. *Moscow, 1912.*

Langley, S. P. Experiments in Aerodynamics. ed. 2. *Washington, 1902.*

Maxim, Hudson. Defenseless America. *New York, 1915.*

Müller, Bruno. Air sacs of the pigeon. *Washington, 1908.*

Peary, R. E. Northward over the "Great Ice." 2 vols. *New York, 1898.*

Petit, Robert. How to build an Aeroplane. *London, 1910.*

Richardson, H. C. Hydromechanic experiments with flying boat hulls. *Washington, 1914.*

Ritter, Wolfgang. Flying Apparatus of the Blow-fly. *Washington, 1911.*

Rotch, A. L. Charts of the atmosphere for aeronauts and aviators. *New York, 1911.*

——— Conquest of the air or the advent of aërial navigation. *New York, 1909.*

Royal Aero Club of the United Kingdom. Yearbook 1912. *London.*

Santos-Dumont, A. My air ships. *New York, 1904.*

U. S. Patent Office. Specifications of patents in Aëronautics. 5 vols. *Washington.*

Verrill, A. H. Gasoline engines, their operation, use and care. *New York, 1912.*

——— Harper's air craft book. *New York, 1913.*

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Aerial Age. vol. 1, nos. 1, 4, 6, 7, 9, 11, 12; vol. 2, nos. 1, 2.

Aero. vol. 2, nos. 6, 20, 22; vol. 3, nos. 1-7, 9-13, 17, 20, 24, 26; vol. 4, nos. 1-2, 5, 7, 10-13.

Aero (London). vol. 5, nos. 104, 105; vol. 6, nos. 106-108.

Aero and Hydro. vol. 4, nos. 14, 15, 17, 20; vol. 5, nos. 13, 22, 24, 26; vol. 6, nos. 1, 4, 6, 8-16, 18-23, 25-26; vol. 7, nos. 1-26; vol. 8, nos. 1-5, 7-17.

Aero Club of America. Bulletin vol. 1, no. 4.

Aeronautical Journal. vol. 12, no. 47.

Aëronautical Society of Great Britain. Report 1st.

Aeronautics. vol. 1, no. 5; vol. 13, complete.

Aeronautics (London). vol. 5, nos. 47, 49; vol. 9, nos. 114, 115.

Air Scout. vol. 1, nos. 1-5.

Aircraft. vol. 1, nos. 3, 6-12; vol. 2, nos. 1, 3-12; vol. 3, nos. 2-4; vol. 4, nos. 7, 10-11; vol. 5, nos. 7-12; vol. 6, nos. 1-7.

American Aeronaut. Jan.-June 1908; vol. 1, nos. 1, 3.

American Mathematical Society. List of officers and members 1915.

American Magazine of Aeronautics. vol. 1, no. 1.

L'Association Général Automobile Revue. vol. 8, no. 2, 1909.

Automobilia. vol. 5, no. 40.

Flight. vol. 3, nos. 45, 49; vol. 4, no. 27.

Fly. vol. 3, no. 12; vol. 4, nos. 1-3.

Mobile Era. vol. 2, no. 5, 1912.

Revue générale de L'aéronautique. October 1911.

Svensk Motortidning. nos. 20-22.

La Technique Aéronautique. nos. 44-45, 49.

TRADE CATALOGUES

American Rolling Mill Company. Story of Armco iron defeating rust. *Middletown, Ohio.*

Asbestos Protected Metal Company. For roofing and siding. Bulletin 55. *Pittsburgh.*

Bower Roller Bearing Company. Roller bearings. *Detroit, Mich.*

Burgess Company and Curtis. Burgess hydro-aeroplane and school of aviation. *Marblehead, Mass.*

——— Burgess-Wright aeroplane. *Marblehead, Mass.*

Curtis Aeroplane Co. Curtis Aeroplanes. *Hammondsport, N. Y.*

Hess-Bright Manufacturing Company. Ball bearings in flour and feed milling machinery. *Philadelphia.*

——— Hess-Bright. *Philadelphia.*

National Corrugated Culvert Mfg. Co. Making of Armco iron.

New Departure Manufacturing Co. Bearing friction and its elimination. *Bristol, Conn.*

Roberts Motor Company. Roberts aviation motors. *Sandusky, O.*

Standard Co. Eagle Marine engines. *Torrington, Conn.*

GIFT OF CARL HERING

American Institute of Electrical Engineers. Report of the Standard Wiring Table Committee. Matthiessen's Standard of Resistance of Copper.

Ayrton, W. E. and Cooper, W. R. Variations in the Electromotive force of Clark Cells with temperature. From Royal Society Proceedings, vol. 59.

——— and Haycraft, H. C. Students' Simple Apparatus for Determining the Mechanical Equivalent of Heat. From *Philosophical Magazine, Feb. 1895.*

——— and Mather, T. The Construction of Non-Inductive Resistances. From *Philosophical Magazine, Feb. 1892.*

——— Galvanometers. From *Philosophical Magazine, Nov. 1896.*

——— Electrostatic Reflecting Voltmeter.

——— and Sumpner, W. E. Galvanometers. From *Philosophical Magazine, July 1890.*

——— Alternate Current and Potential Difference. Analogies in the methods of measuring power. From *Philosophical Magazine, Aug. 1891.*

——— Measurement of the Power given by any electric current to any circuit. From Proceedings of the Royal Society, vol. 49.

——— J. Perry and W. E. Sumpner. Quadrant Electrometers. From Proceedings of the Royal Society, vol. 50.

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GIFT OF BUREAU OF RAILWAY ECONOMICS

The Bureau of Railway Economics have donated various publications during the month to the library.

GIFT OF CARNEGIE STEEL COMPANY

The Company very kindly presented the Library with a complete set of their pamphlets and trade catalogues.

GIFT OF NATIONAL BOARD OF UNDERWRITERS

The Board of Fire Underwriters presented us with a good collection of their publications issued to date.

GIFT OF WESTINGHOUSE, CHURCH, KERR AND COMPANY

A good collection of text books were presented by this company, and are now in the Library.

GIFT OF ARTHUR WORISCHEK

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Clay Catalogue.
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Stock Food Edition.

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[1] A complete list of the officers and committees of the Society will be found in the Year Book for 1916, and in the February 1916 issue of The Journal.

ENGINEERING SURVEY

A Review of Engineering Publications in All Languages. All the leading periodicals of the engineering world, embracing over 1000 different publications, are received at the Library. These are systematically examined for review each month in the Survey.

SUBJECTS OF ABSTRACTS

Arranged in the Order of their Appearance in the Survey.

THIS MONTH'S ARTICLES

Prof. L. Marchis's discussion of various methods for measuring air resistance is abstracted.

In the section on engineering materials are covered the matters of correlation between tensile and bending tests of cast iron, giving among other things an expression for the coefficient of correlation. In the same section is discussed in detail the behavior of metals under alternating stresses.

The corrosion resistance of copper steel forms the subject of an investigation by D. M. Buck and J. O. Handy who found that copper does increase the resistance of steel and iron to atmospheric corrosion.

Data obtained in a French government laboratory show that small amounts (about 3 per cent) of anthracene oil increase the water-proofness of mortars which the author, however, ascribes mainly to the lubricating action of the oil because of which the mortar compresses better under the trowel.

Two papers on semi-steel are reported, in one of which the author shows how to make good semi-steel and in the other the writer denies that there is such a thing as semi-steel.

A paper on pulverized fuel for locomotives is reported and illustrated by a figure showing various parts of a typical pulverized fuel locomotive equipment.

Electrically driven charging cars for coke ovens are described in an abstract taken from a German periodical. In the section hydraulics is given an article describing an automatic hydraulic control valve. The valve gear of the MaB engine with rotary conical valves is shown in detail.

Two articles are given on autogenous welding, one of boiler plates, and the other of high pressure mains. In the same section is given an article on the cost of gas cutting.

The transmitting power of leather belting forms the subject of an article by R. T. Kent, abstracted from the Iron Age. Boiler and steam vessel explosion in Switzerland, the new Wisconsin Boiler Code and flow of steam in pipes are some of the other subjects discussed in reports from various American and foreign periodicals.

Two stage air refrigeration for dry blast, standard numerals for the scale of measuring instruments, etc., are included under Varia.

Aeronautics

The Present State of Aerodynamics, Professor L. Marchis

Beginning of a series of articles on the present state of aerodynamics. The author is Professor of Aeronautics in the Faculty of Sciences of the University of Paris.

In the present article are discussed various methods for measuring the resistance of the air such as the method of free fall used in the Eiffel experiments and the various so-called "car" methods of which there are several modifications. The author in particular describes the car method used at the Aerodynamic Institute of the Saint-Cyr Military School where different cars are used for the study of planes and of propellers.

The car for the study of planes and complete aeroplanes has an electric traction, runs on standard gage rails, and weighs without equipment 5 tons. It can develop a maximum speed of 20 m (65.6 ft.) per second, and has special appliances which permit of registering the vertical component of resistance of the air, the horizontal component and the couple of rotation from which can be determined the direction of the resistance of the air. In order to make a correction for the wind, its strength and direction are registered at a certain fixed point along the line where the tests are made. A similar but more powerful car is used for the study of complete aeroplanes and another special car is used for the study of propellers. The power absorbed by the propeller is measured in two different manners, first by means of a wattmeter registering the electric power consumed by the motor and second by a transmission dynamometer registering the couple transmitted to the propeller.

At the aeronautical laboratory of Chalais-Meudon is used an open truck car running on a narrow gage railway. The power absorbed by the propeller is measured by a registering ammeter and voltmeter.

In the laboratory of the Duc de Guiche an automobile is used for carrying the apparatus under test through the air. In this laboratory great care is taken to establish that the automobile itself produces no influence which might cause errors in observation. Great care has been also taken to select the place for the experimentation in such a manner that the results should not be affected by local conditions.

An entirely different method is used at the laboratory for military aviation at Vincennes. There the principle of the method of measurement is as follows: Assume that a body is rigidly suspended on a wheel rolling down an inclined rectilinear cable. Assume further that the body possesses a plane of symmetry and that the cable is located in that plane. This body will then go down along a cable in such a manner that its plane of symmetry will move parallel to itself and the body will be subject at each instant: (1) to the action of gravity applied to its center of gravity, (2) to the resistance of the air and (3) to the force of inertia applied likewise to its center of gravity. These forces can be decomposed into forces parallel to the cable and perpendicular to it. The force of gravity is opposed to that of the resistance of the air and the force of inertia is parallel to it.

The magnitudes of the components parallel to the cable and perpendicular to it can be registered graphically. When the system is at rest the weight is acting alone, hence the method of registration permits of separating the effects of weight. Then the body is allowed to slide down the cable with the wheel forming a rigid part of the system. At a given moment the acceleration of the system is measured and the components of resistance of the air and force of inertia recorded. The article describes fully how this is carried out in practice, with the cable 155 m (508 ft.) long. (*L'État Actuel de L'Aerodynamique*, L. Marchis, *L'Aérophile*, vol. 24, no. 1-2, January 1-15, 1916, beginning of a series of articles.)

Engineering Materials

Correlation between Tensile and Bending Tests of Cast Iron, Winslow H. Herschel

The article discusses first the subject of correlation generally and then that of correlation between tensile and bending strength of cast iron.

As a basis of his investigation, the author uses the formula for the coefficient of correlation (that is, the degree to which variations in one variable depend on variations in another variable) given by W. I. King which is

$$Y = \frac{\Sigma d_x d_y}{N \sigma_x \sigma_y} = \frac{p}{\sigma_x \sigma_y}$$

where N is the number of pairs of related values of the variables X and Y. d_x and d_y are deviations from the mean while σ with suitable subscript is known as the "standard deviation" and should not be confused with the "mean deviation" which is the arithmetical mean of the deviations from the average taken without regard to either sign. In the case of the standard deviation the + and — signs are eliminated by squaring.

The author derives the average strength and average load from 13 tests of cupola iron and from these data derives first an expression for the standard deviation of tensile strength and then from that the coefficient of correlation; then with the same data he derives the correlation between tensile strength and maximum deflection, and finds that there is no certain indication of correlation.

The relation between tensile and bending tests of cast iron is construed with reference to the previous work of Nagle, Merriman and Burr. The last, by the way, stated that the modulus of rupture of cast iron is only an empirical quantity.

After investigating the relation between the tensile and the bending tests, the author determines the coefficient of correlation and proves that such a correlation does actually exist. The problem, however, could not be considered solved until there has been found a relation between a change in the value of one variable and the corresponding one in the other.

As shown in Fig. 1, the means M_x and M_y intersect at the point M and the lines RR and CC also pass through this point. These last two lines are called the lines of regression. A point from the line RR is obtained by plotting a value on Y against the average value of X, both taken from a table in the article. The values of line CC are similarly taken from a table. In the figure $\tan k\ Ml = b_1 = \frac{r\sigma_x}{\sigma_y}$ and this value is called the regression of X on Y, and it presents the deviation in X corresponding on the average to a united change in the value of Y. Similarly $\tan r\ Ms = b_2 = \frac{r\sigma_x}{\sigma_y}$ is called the regression of Y on X. From this the author derives equations for the line of regression. From these equations it follows that there is no constant

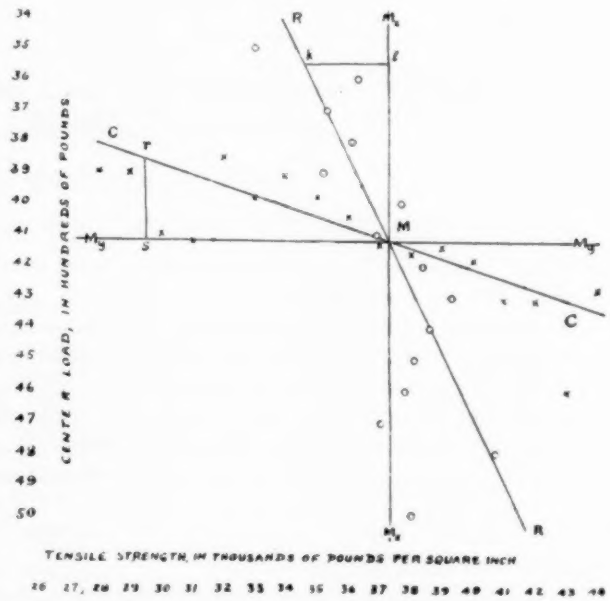


Fig. 1 Diagram of Correlation of Two Magnitudes, and of Lines of Regression

ratio between tensile strength and transverse breaking load as assumed by Nagle.

After describing the method of correlation, the author applies it to determining whether deflection or center load is the better criterion for tensile strength. (*The Technology Monthly and Harvard Engineering Journal*, vol. 2, nos. 7 and 8, pp. 5 and 15, February and March, 1916, 16 pp., 5 figs. *tm.*)

The Endurance of Metals Under Alternating Stresses, B. Parker Haigh

The author draws a distinction between "proving tests" and "experimental research," the difference between the two being in the object of the experiment rather than in the manner in which it is carried out. Tests of the endurance of metals under alternating stresses have seldom been specified as "proving tests" and hardly seem likely ever to form part of the regular series of tests imposed by specifications, which is mainly due to the time which it takes to make fatigue tests.

With the knowledge at present available, it is impossible to anticipate the result of a fatigue test under alternating stress from the proved values of the alternate tensile or shear strength or Brinell hardness, but by the accumulation and analysis of additional data it may reasonably be hoped that a relation will eventually be found between the limiting range

of stress above which fatigue is liable to occur and the other physical properties of the metal, and one of the objects of this paper is to indicate the advances that have been made towards finding connections between the results of fatigue and other tests.

In the view of the writer the continued development of amorphous material with each repetition of stress is to be attributed to the fact that the great strength of the amorphous material is associated with the low modulus of elasticity, while the weaker original metal possesses a comparatively high modulus. A number of tests carried out by the writer have shown that the modulus of elasticity of a specimen of annealed iron or mild steel is always reduced by straining in tension, provided that the effects of hysteresis are eliminated either by allowing some time to elapse after straining before making the second determination of the modulus, or preferably by boiling the specimen in water for a few minutes.

Fig. 2 indicates the results of a typical series of experiments carried out in this manner. In this instance the specimen of annealed wrought iron was strained beyond the elas-

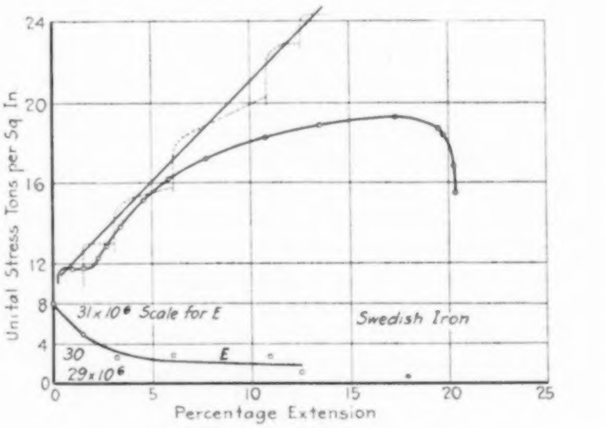


Fig. 2 Typical Behavior of a Metal Under the Action of Alternating Stresses

tic limit in five stages, reaching a total elongation of 12.5 per cent. After each extension the modulus of elasticity was measured after boiling and cooling. The value of the modulus is highest in the annealed metal, and falls quickly at the first strain and more slowly afterwards, the total reduction in the value of the modulus being approximately 6.5 per cent.

The author claims that when the range of alternating stress is maintained above the critical value at which the cleavage of ferrite begins, the material is in an unstable condition and is gradually converted to the amorphous condition. If the range of stress is only a little in excess of the limiting fatigue range, the conversion of the normal crystalline metal to the amorphous phase proceeds slowly, but if the excess is greater, conversion becomes general throughout the mass and the specimen becomes very warm owing to the loss of energy in friction between the constituent particles which shear to and fro relatively to one another during each cycle of stress.

From a number of tests on a sample of Bessemer steel, the author plotted several graphs in various ways. From these graphs he derives the following conclusions. While it may be doubted whether even the most prolonged tests would indicate an absolute fatigue limit, it is clear that for most practical purposes an approximate limit exists close to 35 tons per sq. in. The author writes Dr. Stromeyer's equation of a "law of fatigue" in the following manner:

$$S = F_1 + C\left(\frac{10^6}{N}\right)^n$$

Where S = half the range of stress producing fracture by fatigue, after N cycles of application of stress; F = one-half limiting fatigue range of stress under which fracture would occur, but only after an infinite number of repetitions of the stress; C = constant; n = index, both determined for each particular material by experiment.

It is probable that this simple law only holds for specimens tested in one particular manner, e.g., in direct tension or compression, bending, or rotary bending, and that the values of the constant C and the index n would have to be varied not only with the kind of stress applied to the specimen, but also according to the design of the particular testing machine used. It is always likely that the results of bending tests would depend on the finish of the specimen in greater degree than in the case of tests with direct stress. In tests carried out at University College, London, the endurance of bending specimens which had been turned in a lathe was found to be increased by grinding or polishing and to be reduced by scratching the surface slightly.

The author describes several types of testing machines for alternating stresses, among them the one devised by himself (for a detailed description see *Engineering*, November 22, 1912), in which an alternating current magnet is employed to generate the whole of the pull applied to the test piece without the agency of resonance. He also describes the method by which the intensity of the alternating stress is measured and the machine standardized.

From the experiments made it appears that the effect of a certain degree of extension is very much the same no matter whether that extension has been produced by a steady or by a pulsating pull. The only slight difference is that the metal strained by steady load is not quite so stable as when strained by pulsating stress, giving way slightly under pulsating stress but reaching the full stable condition corresponding to any particular degree of extension.

This last effect was found to be very marked in annealed copper wire. The larger alternating stress testing machine has been used in the engineering laboratory of the Royal Naval College, Greenwich, and also by the author in connection with several researches on steels and alloys, of which the paper presents data referring to the tests of naval brass and muntz metal. Tests were also made on specimens of Swedish wrought iron to ascertain to what degree the endurance of the metal was affected by cold working and by heat treatment, Swedish wrought iron being employed in order to isolate ferrite, the chief constituent of mild steel. Three series of tests were carried out in order to compare the effects of different treatments in each series, the stress being varied between equal intensities of tension and compression and the frequency maintained at 2000 cycles per minute. *First series*, no treatment, annealed metal. *Second series*, similar specimens strained by direct tension, the elongation being the same in all cases, 10 per cent. *Third series*, similar specimens strained in the same manner and subsequently boiled in water at 100 deg. cent. for 30 minutes to restore elasticity.

It was found that the results of each set were highly consistent among themselves, but that the fatigue limits indicated by the three differed appreciably. The endurance was considerably increased when the metal had been strained and was further increased when the strained metal had been boiled.

Several tests were made on structural steels, one a mild steel and the other a stronger Bessemer steel containing about

0.35 per cent carbon. It was found that the fatigue limits of the two metals were very nearly alike, although the tensile strength and yield strength differed quite widely. The values of the ratio between the fatigue limits and ultimate strength likewise vary widely, and it is probable that the effects of other elements than carbon present in the metal are important. The author believes that it is probable that impurities exert their harmful influence by dissolving in the ferrite and thereby increasing its hardness, at the same time changing the modulus of elasticity so that cleavage between ferrite and cementite occurs more readily under a given average stress. However, experiments made by the author show that the value of the modulus of elasticity cannot be employed as a criterion towards the fatigue limit even when measured with reliable apparatus.

The article also reports experiments on mild steel under combined alternating and steady stress, the results of which are expressed in diagrams and a formula. (*The Journal of the West of Scotland Iron and Steel Institute,* vol. 23, no. 1, p. 17, November 1915, 32 pp., 26 figs. *etA.*)

Research on the Corrosion Resistance of Copper Steel, D. M. Buck and J. O. Handy

Report of tests made in order to obtain definite information as to the influence of the presence of varying amounts of copper and other elements when alloyed with steel, on the corrodability of the latter.

Previous experiments by the same authors were reported in the *Journal of Industrial and Engineering Chemistry,* 1913, page 447; *The Iron Age,* June 3, 1915, and *The Iron Trade Review,* June 10, 1915.

The tests were conducted on full size uncoated sheets under exact service conditions, extreme care being taken so to plan the work that those differences found in the various grades of steels used could be safely ascribed to the influence of the particular element which had been added. The tests covered additions of phosphorus, silicon, aluminum, roll-scale and finally the addition of cold steel to the metal ingots of the heat. The data of the tests are reported in tables, and to a certain extent in diagrams and illustrations (Cp. Fig. 3).

Open hearth and Bessemer steels were used in these tests.

As regards the reliability of tests on small pieces when made by determining the losses in weight on exposure, the authors point out that the results accord in a remarkable manner, and that the weight losses corresponded to the relative endurances of the large sheets. In these experiments, the writers adopted the practice of removing and cleaning one-half of the small test pieces after the lapse of several months, allowing others to remain exposed for a somewhat longer period. This was done in an effort to determine if there was any tendency of the rust film to behave differently on different sheets. It was thought that the sponge-like rust which is normally formed on non-copper steels might accelerate corrosion more than the dense adherent film on copper steels. This idea proved to be correct. The results are summarized by the writers in the following manner:

Sheet steel or iron containing copper shows greatly increased corrosion resistance when exposed to atmospheric conditions. The most effective amount of copper to be used for this purpose is approximately 0.25 per cent. Smaller amounts of copper down to as little as 0.04 per cent have a considerable influence in lessening corrosion, but the results are not as good as with the higher amount mentioned above. Work previously done by one of us has indicated that 0.15 per cent copper is in nearly all cases as efficient as 0.25 per cent. Higher amounts of copper, up to 2 per cent, give little or no added benefit.

Copper is as necessary in the so-called "pure irons" to insure corrosion resistence as it is in normal open-hearth and Bessemer steels. Phosphorus added to open-hearth steel slightly lowers the corrosion rate. Silicon, while probably without effect in the amounts normally present in open-hearth and Bessemer steels, accelerates corrosion when added in amounts from 0.10 to 0.30 per cent. The addition of small amounts of aluminum probably has little influence on corrosion; the above tests indicate it to be harmful rather than beneficial. The addition of sulphur to steel greatly increases the corrosion rate and when residually present in abnormal amounts, it is probably also detrimental from a corrosion standpoint. The addition of cold steel to molten steel does not lower the corrosion rate, but if it has any influence at all, it is to increase the corrosion.

Loss in weight determinations on small test pieces are found to be accurate and valuable when determining the relative corrosion resistance of various sheet metals. The

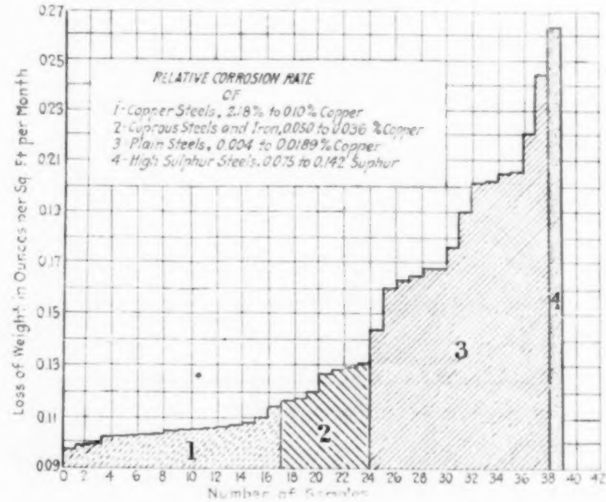


Fig. 3 Relative Corrosion Rates of Various Kinds of Copper Steel

method of cleaning such test pieces with ammoniacal ammonium citrate solution is found to be the most convenient and accurate thus far investigated.

CONCLUSIONS

I Copper increases the resistance of steel and iron to atmospheric corrosion:
   1 Its influence is apparent when the copper content reaches only 0.03 per cent.
   2 Its effect is almost at a maximum when the copper reaches 0.05 per cent.
   3 The best amount of copper for commercial steel has been found to be 0.25 per cent.

II Steel containing 0.25 per cent copper outlasts "pure iron" containing 0.04 per cent copper.

III Steel containing 0.05 per cent copper lasts as long as "pure iron" containing 0.04 per cent copper.

IV Sulphur in steel accelerates corrosion very markedly.

V Sulphur oxides in the air accelerate the corrosion of steel.

VI Copper in steel counteracts or retards both the corroding influences noted in IV and V.

(*The Journal of Industrial and Engineering Chemistry*, vol. 8, no. 3, p. 209, March 1916, 8 pp., 9 figs. *eA.*)

Waterproofing of Mortars by Anthracene Oil, R. Feret

The article discusses the question of water-proofing of mortars by anthracene oil on the basis of experiments made by the author in the laboratory of the Ponts et Chaussées in Paris, France.

In the first group of tests a mortar was used consisting of one part of cement to three parts of sand with the weight of the water equal to 10.5 per cent of the solid matter. The tests were made on prisms 4 x 4 x 16 cent. (1.5 x 1.5 x 6 in.). These prisms after standing in the air for one week were kept under water for three weeks. In the first series of tests made it was found that two mortars with oil let through practically an equal amount of water, but considerably lower than that which penetrated through mortar without oil, so that the addition of oil was shown to have materially increased the water-proofness of the mortar.

In the second series, even though the mortars had been allowed to harden for a longer time before being subjected to the action of water under pressure, the permeability was under the same pressures in all cases greater than in the first series. In this series the difference in permeability between the mortar with oil and that without, was a good deal less than in the first case. In fact a mortar with 5 per cent of oil proved to be even a little more permeable to water than without oil. Curiously enough this difference changed in direction after a maximum pressure was attained, and remained in favor of the oil-treated mortars even after the pressures were reduced. This series of tests showed on the whole that anthracene oil has approximately the same action as far as water-proofing of mortar is concerned, as heavy petroleum oils, but it seems also to considerably reduce the strength of the mortar so that it does not appear advisable to use more than 5 per cent of the weight of the cement.

A further series of tests was then made with additions of from 3 to 5 per cent by weight of oil to the cement. In this series it was found that during a continuous test the mortar with 3 per cent of oil proved to be in the first period of the test the most permeable of all; then suddenly the 5 per cent mortar started to let through more water than the others which indicated that the water had found a passage between the mold and the mortar. On the whole, however, the mortars with oil let through less water than those without oil.

The author comes to the conclusion that mortars with 3 per cent of anthracene oil are less permeable to water than those without oil. The mortars with 5 per cent of water have given quite variable results. The addition of 3 per cent of oil did not materially affect either the resistance or the adherence of the mortar. The adherence to iron never decreased more than 26 per cent and sometimes even increased slightly. While it appears, therefore, that in most cases there is an advantage in incorporating into a mortar anthracene oil to the amount of approximately 3 per cent of the weight of cement, it is impossible to tell now in how much this addition will increase the water-proofness in a particular practical application when the conditions of filtration are quite different from those used experimentally in the laboratory.

It appears that such additions, however, are efficient only when the mortar is very compact in itself, that is when it consists of materials of proper granular structure. The maximum of compactness corresponds approximately to a mixture of two parts of sand of as large grain as possible with 1 part of fine grain (including cement). In addition to that the compactness of a mortar depends very largely on its strength and the conditions of operation and it is quite probable that the increase of water-proofness produced by quite small additions of oil is due less to the bottling of the pores than to its lubricating action because of which the mortar compresses better under the trowel. (*L'Imperméabilisation des Mortiers et L'Huile Anthracénique*, R. Feret, *Annales des Ponts et Chaussées*, partie technique, vol. 28 of series 9, no. 4, p. 51, July-August 1915, 20 pp. *e.*)

Semi-Steel, Y. A. Dyer and Richard Moldenke

Discussion of the question of what is semi-steel, how it should be made, and what is its practical value. The article consists of two papers, one by Y. A. Dyer, and the other by Dr. Richard Moldenke.

The first paper of Mr. Dyer takes the position that steel can mix homogeneously with pig iron and cast scrap under proper conditions. By proper mixing of from 10 to 40 per cent (even 50 and 60 per cent) of steel of low carbon preferably in the ordinary cupola along with pig iron of suitable homogeneity, or pig iron and selected cast scrap, a sound, tough, close-grain and easily machined casting of high tensile and transverse strength can be produced.

In the manufacture of semi-steel the pig iron to be used as a base metal should be under 0.60 per cent in phosphorus and over 1 per cent in manganese. The silicon in the pig for work requiring close-grain and high strength should be from 2.25 to 2.45 per cent. For small and comparatively thin castings the silicon in the pig should run from 2.50 to 2.80 per cent. The lower the sulphur the better. If low grade pig iron should be used with the above base metal, No. 3 or No. 4 foundry iron will suit; if scrap should be used, No. 1 machinery is best.

Low carbon steel is preferable in the mixture, such as croppings from angle bars and structural material, concrete bars, cast steel shafting, pipe, rails and boiler plate, all of which will range approximately as follows in analysis: Silicon, 0.03 to 0.35 per cent, sulphur, 0.05 per cent or under, phosphorus, 0.01 to 0.10 per cent, manganese, 0.40 to 0.80 per cent. The manganese should be watched closely in the mixture and ranged from 0.40 to 0.75 per cent in the casting. Manganese in the pig iron and other material used will more uniformly mix in the bath than if it should have to be supplied in the form of ferro manganese. If ferro manganese should have to be used, lump form charged in the cupola will give better results. Proper charging of the material and correct cupola practice are highly important elements of success.

The article reports data of tests of horizontal bars 1 in. square. The horizontal bars showed a strength from 35,000 to 37,000 lb. in tension, and about 3600 to 3700 lb. under transverse stress. The vertical cast bars broke at stresses from about 5500 to 7500 lb. per sq. in.

Dr. Richard Moldenke in his paper objects to the use of the term "semi-steel." The name was introduced in good faith at a time when little was known of the metallurgy of cast iron, but it should not be used now with our present extended knowledge of the properties of materials and their metallurgical characteristics.

As regards the data in Mr. Dyer's paper the writer calls attention to the fact that cast iron with silicon contents from 1.45 to 1.65 will often show tensile strengths in 1 in. square bars of 33,000 to 37,000 lb. per sq. in. without the addition of any steel to the mixtures, hence there does not seem to have been any gain from the addition of steel.

Melting large percentages of steel scrap with gray iron

means quick setting metal particularly if only just the right amount of fuel has been used which is complicated by undue oxidation of the steel, before it melts and a not too high temperature of the metal from the spout. Hence molds as ordinarily gated will not allow a proper feeding of the casting and wherever the thinner sections about a heavy point may have set the liquid portions unable to draw in fresh metal will result in iron with heavy draws and even the sound portions will show very open interior structures Only some adaptation of the "top pour" permitting the descent of the molten metal in small streams straight to the bottom and allowing the metal to remain quiet as the mold fills and draw from above to set sound, will give good results.

The author claims that the test bar will show up wonderful results and yet the casting may be quite below par. He believes further that when a customer buys castings made with steel scrap added to the mixture, he takes greater chances.

The writer has oftentimes run cupola heats of 100 per cent steel scrap and excess of fuel had to be used to get serviceable results but the product was cast iron just the same and nothing "steely" could be traced in the castings made. In fact, the author appears to believe that but for the propaganda of certain manufacturers, the term "semi-steel" would have been, as he expresses it, "decently buried and long forgotten," as it serves mainly to fool the foundrymen and consumers of castings. (*The Iron Age,* vol. 97, no. 9, p. 542, March 2, 1916, 3 pp. *cp.*)

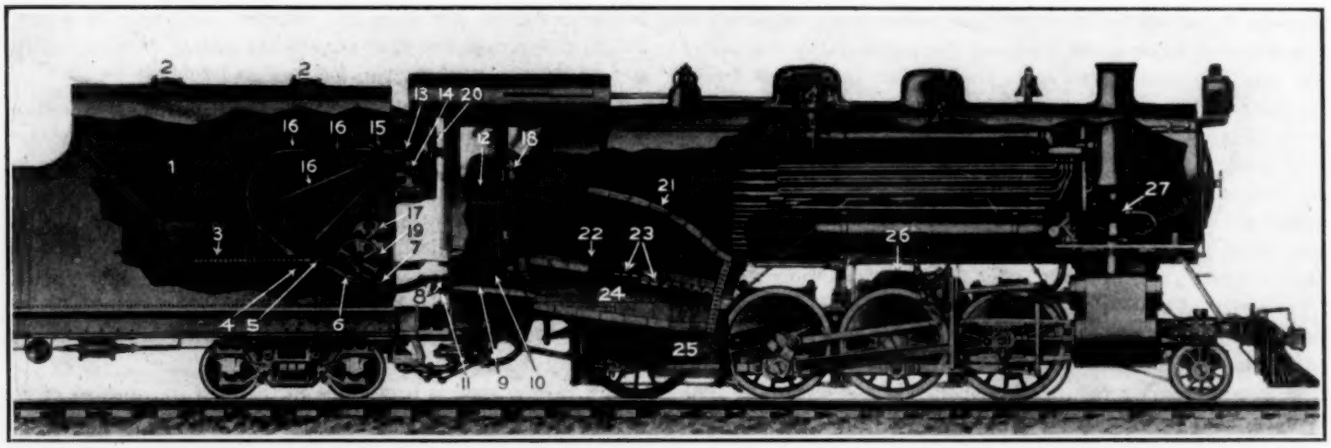


FIG. 4. TYPICAL PULVERIZED FUEL LOCOMOTIVE FURNACE

1. Enclosed Fuel Container
2. Fuel Supply Inlets and Covers
3. Fuel Conveyor
4. Fuel and Pressure Air Feeder
5. Fuel and Pressure Air Commingler
6. Fuel and Pressure Air Outlet
7. Fuel and Pressure Air Flexible Conduit
8. Fuel and Pressure Air Nozzle
9. Fuel and Air Mixer
10. Firing up Opening
11. Induced Air Inlet Damper
12. Control for Induced Air Inlet Damper
13. Pressure Blower
14. Steam Turbine or Motor for Pressure Blower
15. Pressure Blower Manifold
16. Pressure Blower Conduits
17. Steam Turbine or Motor for Fuel Conveyor, Feeder and Commingler
18. Control for Steam Turbine or Motor for Fuel Conveyor, Feeder and Commingler
19. Operating Gear, Shaft and Clutches for Fuel Conveyor, Feeder and Commingler
20. Switchboard (when electrical equipment is specified)
21. Security Arch
22. Primary Arch
23. Auxiliary Air Inlets
24. Combustion Furnace
25. Self-Clearing Air Cooled Slag Pan
26. Turbo-Generator (when electrical equipment is specified)
27. Combination Engine and Turbo-Generator Exhaust Nozzle and Stack Blower

Fuel

PULVERIZED FUEL FOR LOCOMOTIVES, John E. Muhlfeld

Brief historical sketch of the development of the use of pulverized fuel for locomotives and data on the present state of the art.

The author believes that the development of means and methods for burning pulverized fuel in steam locomotives has now passed the experimental stage and commercial applications will be made as rapidly as the equipment can be produced.

Fig. 4 shows a typical application of pulverized fuel burning equipment to a consolidation type of steam locomotive indicating among other things the names of the parts.

From investigation to date any solid fuel which in a dry pulverized form will have two-thirds of its content combustible will be suitable for steam generating purposes. In tests with semi-bituminous coal from Brazil, S. A., the sulphur averaged from 3 to 9 per cent and the heating value from 10,900 to 8,800 B.t.u., and no difficulty was found in maintaining maximum boiler pressure on the locomotive.

To produce, however, the most effective results, pulverized fuel should contain not to exceed 1 per cent of moisture and should be of uniform fineness so that not less than 95 per cent of the total will pass through a 100-mesh and not less than 80 per cent of the total will pass through a 200-mesh screen. The total cost of preparing pulverized fuel properly in a suitably equipped drying and pulverizing plant will range from 15 to 45 cents per ton depending upon the capacity of the plant. (Paper presented before the *New York Railroad Club* on February 18, 1916, 10 pp., 3 figs. *dp.*)

FUEL ECONOMY, H. C. Woodbridge

Consideration of the general elements affecting fuel economy, especially from the point of view of proper organization of the firing service.

Among the main points to which the author calls attention is the necessity of proper training of firemen. In 1907, 300 firemen were specially trained by the officers of the Hamburg Society for the Prevention of Smoke. A report of this society shows a thermal efficiency with the regular or untrained firemen of 66.6 per cent, and a thermal efficiency of the same plant with trained firemen of 72.7 per cent. Similar experiments conducted in the Pennsylvania Railroad Company's laboratory at Altoona, under the direction of Professor Goss, have shown an efficiency of a locomotive boiler to be 73.2 per cent when fired by experienced men and 59.7 per cent when fired by inexperienced men. (*Railway Club of Pittsburgh,* vol. 10, no. 3, p. 64, January 28, 1916, 4 pp. *g.*)

Furnace with Adjustable Grate Area

The article describes a series of comparative tests on a 150 h.p. boiler in a building in New York City provided with an adjustable furnace. This furnace consists of a sliding bridge-wall operated back and forth by hand, through a worm gear rotating a cross shaft on which are maintained two pinions geared to racks secured to the underside of the movable bridge-wall framework. The wall is moved out over the grate bars sliding upon side supporting bars set alongside the furnace wall.

The rear of the bridge has an extension in the form of a cover which slides over a fixed frame secured to the brick-work of the bridge wall. The frame is made with recessed tray which is filled with sand so that a joint is maintained between the sliding bridge and the fixed frame, preventing the passage of air through the unused portion of the grate to the combustion chamber. On the return of the bridge, the rear edge scrapes a clean surface over the sand bed and renews the air joint in this manner.

The tests are made with a return tubular boiler. No data of tests are reported. (Novel Method of Adjusting Grate Area, *The Isolated Plant,* vol. 8, no. 3, p. 15, March 1916, 1 p. *d.*)

Electrically Driven Charging Cars for Coke-Ovens, K. Dobbelstein

Description of an installation at a German mine plant where the charging cars for coke-ovens are driven electrically.

Small manually driven cars were formerly used; then without changing the shape of the cars, two of them were interconnected and a motor installed in the angle between the hoppers. Fig. 5A shows how this was accomplished. The drive (Fig. B) is by means of a fully enclosed direct current motor *m* running on 110 or 220 volts and delivering from 5 to 6 h.p. The power is transmitted from the gear *z* through the chain *g* onto the axle of the car. Forward and reverse motion

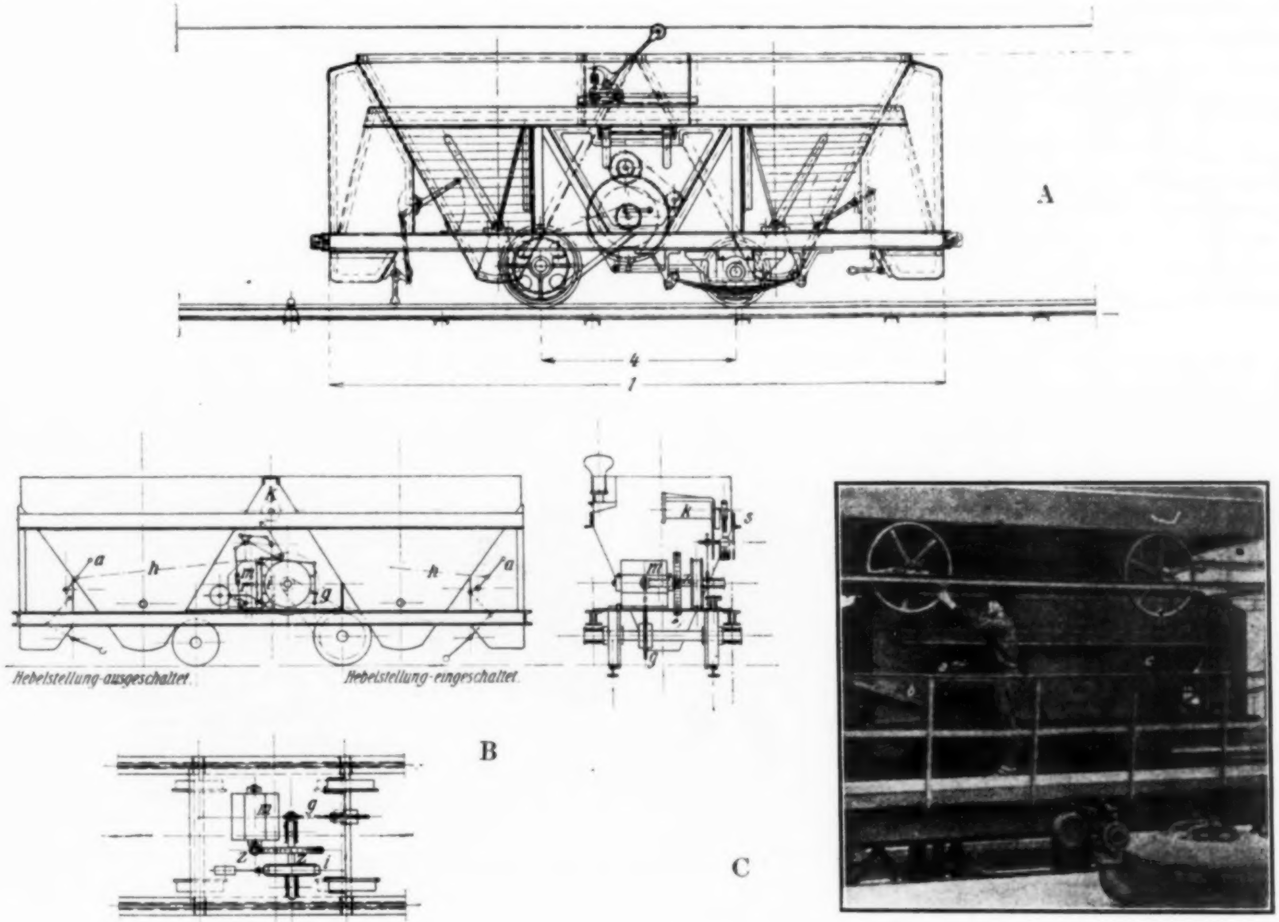


Fig. 5 Electrically Driven Charging Cars for Coke-Ovens

is obtained by the reversing controller *k*. A special mechanical arrangement maintains the switch lever in its proper position after the motor has been cut in. Simultaneously with the starting of the motor a mechanical brake *i* (or an equivalent magnetic brake) connected with the lever, is set into operation, in the first case by air and in the other by electric current. As shown in Fig. B, proper lighting is provided for night work. It has been found that the operation of the car requires little current; a car of 3 ton capacity running at 1.2 m (3.94 ft.) per second and using 220 volts, requires 15 amperes.

Fig. C shows the filling of the car from the coal tower. The operator brings the car right under the discharge opening of the tower, holding his hand all the time on the switch lever *a*. The wide lever *b* located in an inclined position in front of the operator opens and closes the discharge valve on the tower. There is also a third lever *c* visible in the rear but concealed in the front section of the figure by the body of the operator. This lever operates the jarring device used when discharging the coal. The operation of the car is so simple

that a workman can manage it without any previous training. As soon as three cars have been filled from the tower and switched in one after another, two of them are sent forward without any operator on them direct to the proper oven, while the operator goes after in the third car. In this manner a battery of 60 to 80 ovens can be taken care of by a single man so that there is a large saving in attendance in addition to which the safety of operation is materially increased. (*Die Beschickung von Koksöfen mit kleinen, elektrisch betriebenen Fülltrichterwagen*, K. Dobbelstein, *Elektrische Kraftbetriebe u. Bahnen*, vol. 14, no. 5, p. 49, February 14, 1916, 3 pp., 6 figs. *d.*)

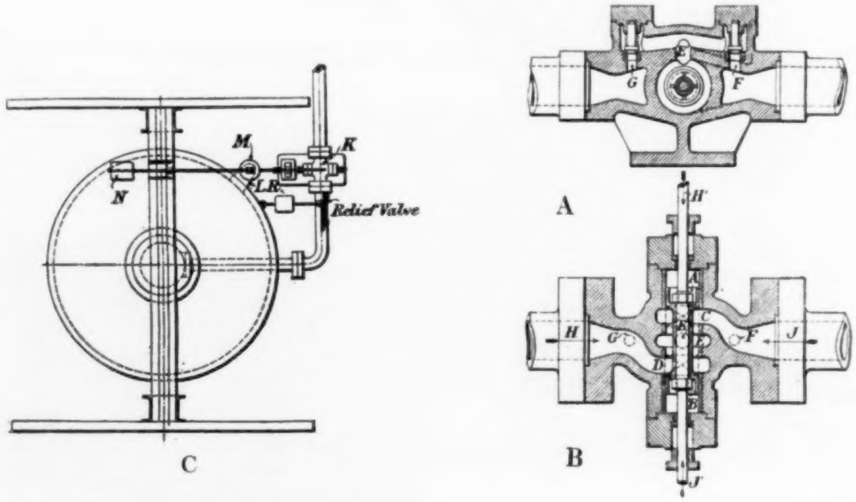
Hydraulics

AUTOMATIC HYDRAULIC CONTROL-VALVE

Description of an automatic hydraulic control-valve primarily designed to be placed in the pipe line connecting an accumulator in an outlying district with the mains of an hydraulic system.

To be of the greatest value such an accumulator must on the one hand be freely responsive to the pressures in the main, and on the other hand avoid the difficulty usual with the freely responsive accumulator in that it makes violent contacts with the stops at the top and bottom limits of the stroke. To meet this requirement the device described here consists of a combination of valves contained in one body. In Fig. 6*A* and *B* it is seen that the valve has a double headed piston *AB* working in a body having two ring ports *C* and *D*, with an annular space *E* between, connected to the outside of each port by a small by-pass *E'* fitted with the check valves *F* and *G*. The length and stroke of the piston are such that when in mid-position both ports are uncovered and there is, therefore, a clear passage through the valve in either direction. When the piston is moved over to either extremity of its stroke, it covers one of the ports blocking the passageway.

Now assuming the water to be flowing into the accumulator in the direction of arrow *H*, the ram will rise until it approaches the top of its stroke when the gear will move the valve piston in the direction of *H'* until port *C* is closed and the motion of the ram thus stopped. If during the closing or closed period the pressure should at point *H* be reduced by a draught in the main, water passing through the by-pass *F* in the direction of the arrow *J* would cause the accumulator ram



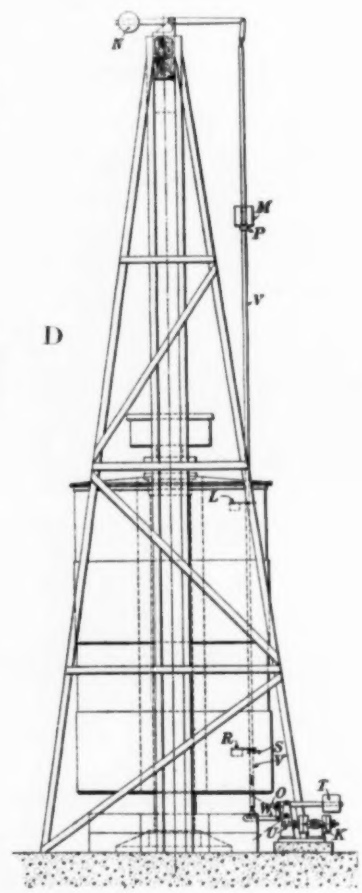


FIG. 6 AUTOMATIC HYDRAULIC CONTROL-VALVE

to descend and in so doing move the piston back to mid-stroke, thus restoring the full area through the valve passage. On the descent of the accumulator to the bottom position the movement of the piston and water will be similarly affected.

C and *D* show the arrangement of the control valve and the application of the operating gear. The control valve is placed at *K* in the pipe connecting the hydraulic main with the accumulator, the accumulator casing being provided with the contact brackets *L* and *R* through which passes the tappet rod *V*. In figure C the valve is in mid-position and the accumulator is shown approaching the bottom resting blocks at the point when the bracket *R* commences contact with the tappet *S*, thus depressing the lever *W* and gradually closing the valve through the spindle at *U*.

As the accumulator ascends, the weight *T* brings the lever back to mid-position. The same happens at the top of the stroke. As the accumulator descends the weight *M* again rests on the tappet *P* thus overhauling the weight *N* and bringing the lever *W* back to mid-position. The valve and gear remain in this position whilst the accumulator is moving between the bottom position shown in Fig. C and the top position when the bracket *L* lifts the weight *M* off the tappet at *P*. (*Engineering*, vol. 101, no. 2614, p. 102, February 4, 1916, 1 p., 4 figs. *d.*)

Internal Combustion Engineering

THE MAB RACING ENGINE WITH ROTARY CONICAL VALVES

Description of the MaB racing engine used on an English cycle car. The most important points are the shape of the valve and the type of valve operation employed; the rotary valve employed permits of a continuous instead of an inter-

mittent movement so that it is possible to drive the valve direct from the crankshaft without the interposition of springs, cams, or any other variables which may in time affect the correct operation of the valves.

The valve itself is of conical formation as shown in Fig. 7A and its shape is said to be responsible for a very compact combustion chamber which allows of the full force of the explosion being expended upon the head of the piston. As seen in Fig. B the shape of the combustion chamber is such that the gases have a very easy path both from the carbureter and into the exhaust pipe. The construction of the driving gear looks somewhat complicated but this is due to the large number of ball bearings employed so that as much friction may be avoided as possible.

Under the influence of compression and explosion the rotary conical valve bears against the head of the cylinder but when no pressure is on the valve the weight is taken by the large ball thrust bearing seen just above the cylinder head. The coil spring on the upper part of the valve stem, Fig. B, is to keep the valve in close contact with the cylinder walls to prevent leaks. In addition this coil spring permits of a flexible connection between the valve and the cylinder which will allow the oil to be forced on the face of the valve from the force feed lubricator seen at the right hand side of the engine section.

The valve operating gear is as follows: (Fig. C) Mounted on the front of the crank shaft is a spiral gear which drives a vertical shaft at the same speed as itself. This vertical shaft measures with the horizontal shaft running the length of the cylinders. Mounted on this longitudinal shaft are four skew gears which mesh with gears mounted on each rotating valve having double the number of teeth and the valves, therefore, run at half crankshaft speed.

The engine has been constructed for purely racing purposes. (A Revolutionary Engine Design, *Gas Energy*, vol. 10, no. 2, p. 35, February 1916. 3 pp., 4 figs. *d.*)

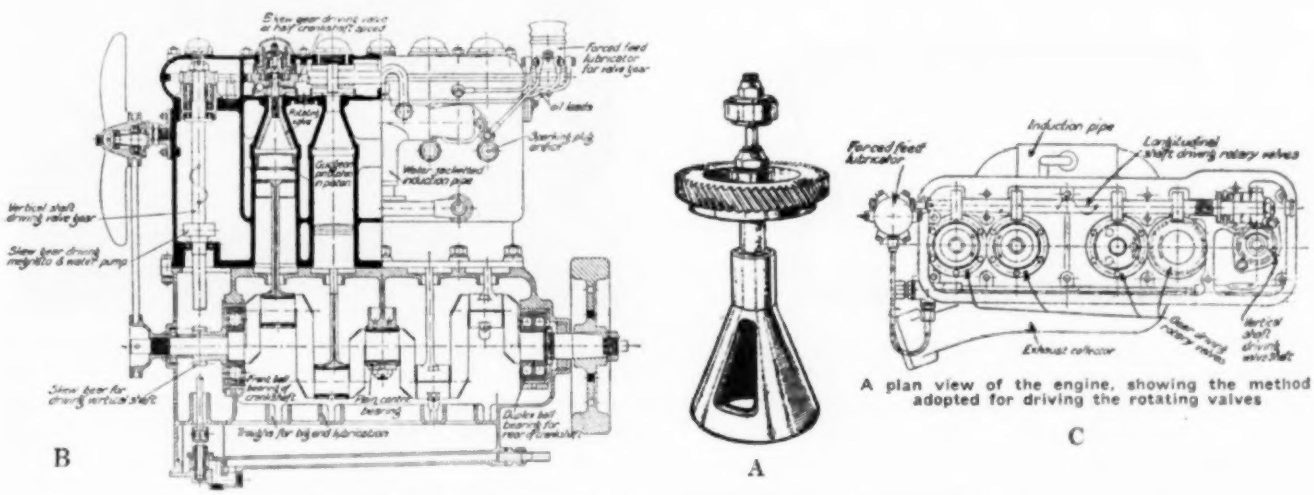


Fig. 7 The MaB Racing Engine and Its Rotary Conical Valve

Machine Shop

The Autogenous Welding of Boiler Plates

Abstract of a report issued by the Swiss Society of Steam Boiler Owners based on data collected by the Federal Laboratory for the testing of materials in Zurich.

It was found that the test pieces which broke at the weld had an average tensile strength of 76 per cent only and an elongation outside the fracture of 39 per cent, whilst the averages of those which broke outside the weld were respectively 87 and 66 per cent. In considering the tensile strength, however, it should be remembered that the welded pieces were annealed, a process which generally tends to derease the tensile strength while increasing the elongation. Brinnel tests for the original plate gave an average hardness number of 115.6 and the average for 52 autogenous welded plates was 102.8 or 89 per cent of the hardness of the original plate measured outside the weld and 108.2 or 94 per cent of the hardness of the original plate measured at the weld. This decrease of 11 per cent in hardness represents approximately the influence of annealing.

The resilience of the metal as tested by impact bending tests on notched bars seems to have undergone a marked decrease owing to the welding conditions, a decrease larger than the decrease in tensile strength. An interesting fact is that the plates which in the tensile tests have given bad results gave satisfactory results in the impact bending tests, and it would appear that in regard to resistance to bending under impact the welds which lack in homogeneity and are fibrous, are superior to those which have greater uniformity and are more homogeneous. In general those plates on which the consumption of oxygen and gas were the highest gave better test results.

The tests did not afford any proof of the superiority of electric welding over autogenous welding. It must be said, however, that the tests were not carried out in a manner such as to establish an accurate comparison between the two processes. (*Engineering*, vol. 101, no. 2614, p. 95, February 4, 1916, 3 pp., 4 figs. *e.*)

Welding of High Pressure Mains at Springfield, Mass., A. S. Hall

Description of the welding of high pressure mains, presented in such a manner as to give information that may be used as the basis for estimating costs.

The welders on this job started as green men, recruited from the ranks of the regular street gangs of the company. As soon as one man became proficient, another man was broken in, until six capable welders were available. At first, however, because of their inexperience, the men were lavish in the use

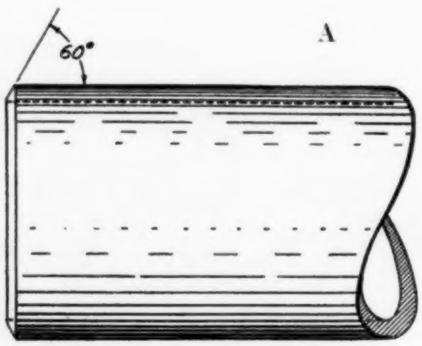
of oxygen, acetylene, filler metal, etc., and the joints were slow in being made and often had to be rewelded. The detailed cost data are given in the article and show that the total cost of laying pressure main was nearly $15,000, while the cost per joint is estimated as follows:

Labor	$.6010
Oxygen	.2296
Acetylene	.2224
Filler Metal	.0522
Total cost per joint	$1.1052

It was found that the welding of double length pipe was the most economical method of laying high pressure mains. The cost data for another job are given in the same article, indicating a total cost per joint of $1.3016.

In ordering plain end pipe for a welded main such as has been described, an important feature is the bevel to which the ends of the pipe are cut. The writer has found from experience that the best angle for this bevel is 60 deg. to the horizontal, as shown in Fig. 8A.

A



B

Fig. 8 A Best Angle for Bevel in Welding of High Pressure Main; B Best Position of the Welder

It is absolutely necessary, in order to make a tight joint, that the inner edges of the two pipes be fused together before any filler material is applied. There must be enough stock in the thin edges caused by the bevel to make this fusing possible. A bevel angle very much less than 60 deg. to the horizontal does not give this necessary amount of stock, so that a hole is frequently burned, through which molten metal runs to the inside of the pipe.

On the other hand, a bevel angle very much greater than 60 deg. to the horizontal not only leaves the inner pipe edges too thick to be easily fused, but it does not leave sufficient room in the groove for a proper amount of filler material.

It has been found more economical to weld together and test long sections of pipe before placing them in the ditch. Note in Fig. 8B, the position of the welder, sitting on a small wooden bench, with the arms resting on either knee. Such a position can be maintained for some time before becoming tiresome. No welder was allowed to light a torch without having on a proper pair of goggles.

In view of the extreme changes of temperature with the seasons in New England, an expansion joint was placed at intervals of about 1000 ft. to take care of the expansion and contraction of the mains. Extra heavy semi-steel screw end valves were used.

One of the great advantages of welding mains is the number and variety of bends and fittings which can be made on the job. In this case, all drip-pots, tees, and most of the bends were welded in this way. To facilitate this work, a number of sheet metal patterns were made, similar to those used in making stove pipe, to aid the welder in properly cutting the pipe.

The following data, as to the relative cost of welded high pressure mains as compared with threaded and coupled mains, are given: The writer's companies received the following data in answer to a recent inquiry as to the relative cost of plain end pipe and threaded and coupled pipe:

Size of Pipe	*Cost per Foot Threaded and Coupled Pipe*	*Cost per Foot Plain end Pipe*
2	$.09	$.085
4	.27	.26
6	.48	.46

If, for example, a 6-in. pipe is used, by using plain end pipe, a saving of $0.02 per ft. or $0.80 per double length is made before the pipe leaves the mill, which goes a long way toward paying for a joint. (*The Gas Age*, vol. 37, no. 5, p. 259, March 1, 1916, 6 pp., 21 figs. *d.*)

Woodruff Keys and Keyways

The article consists of two tables and a brief introduction. In Table 1 the dimensions of Woodruff keys and key-ways have been computed and tabulated for keys and key-ways suitable for shaft diameters from ½ to 2 in. inclusive, while Table 2 gives the dimensions of cutters of various sizes. The tables are very complete as every essential dimension is given in plain figures. (*Machinery*, vol. 22, no. 7, p. 586, March 1916, 2 pp. *p.*)

Cost of Gas Cutting, J. F. Springer

Data on cost of cutting steel by the oxy-hydrogen method, obtained partly by calculation and partly from a European source.

The data by calculation were obtained from a lot of miscellaneous work, in all 38 cuts, varying in area from 1.56 to 75.6 sq. in. From both sources it has been found that to cut 1/3 lineal foot, between 5.1 and 5.4 cu. ft. of oxygen are required. For work thicker than 1 in., the oxygen becomes a very decisive factor, it costs more per foot all the time and for heavier work the amount becomes rapidly greater relatively as the work increases in thickness. The article contains two tables, one on the cost of cutting steel plate and the other cost of cutting steel bars of circular section, both by the oxy-hydrogen process. The second table shows that 4.8 cu. ft. of oxygen is required to cut a 4-in. bar (area of cut 12.6 sq. in.)

Calculation shows that it takes approximately the same amount of oxygen to cut a given area in work of a given thickness whatever be the form of the cross section cut (in applying this rule it is necessary to take the maximum thickness as the basis). There is, however, a small advantage in favor of work of even thickness especially in the case of small work. With the given cutting torch there must be a certain pressure of oxygen which corresponds with the speed determined by the heating flame. A stronger pressure will be useless and occasions waste, and weaker pressure will require the forward speed to fall below its possibilities. (*Machinery*, vol. 22, no. 7, p. 581, March 1916, 1pp. *ep.*)

Mechanics

Transmitting Power by Leather Belting, R. T. Kent

A series of tables embodying the latest investigations showing tensions and horsepowers at which belts will give the best service and cost the least for maintenance and repairs. The purpose of these tables is mainly to provide an answer to each of the three following questions (assuming the pulley size to have been determined): what horsepower is to be transmitted; what size of belt should be used to transmit it; and under what tension should the belt be placed on the pulleys.

The writer gives the following determination of the more satisfactory belt drive: It is that one which will at all times transmit the necessary amount of power and at the same time cost the least for repairs and maintenance, and cause the least possible loss by machine shut-downs for the purpose of making belt repairs in working hours.

To have a satisfactory belt drive the following considerations must be taken into account when the drive is laid out: the conditions of use of the belt, whether it is readily accessible or not; the velocity at which the belt will travel; the arc of the pulley with which the belt is in contact; the tension per sq. in. of cross section under which it is first placed on the pulleys; the tension per square inch of cross section to which the belt may be allowed to fall in service before it is taken down and retightened.

The tables which accompany the article are based on the latest investigations of belting practice, viz. those of Carl G. Barth, and give horsepower and maximum and minimum tensions of leather belts per square inch of cross sectional area, cross sectional area of belts, arc of contact on smaller pulley, velocity of belts. The theory of belting practice is discussed on the basis of Mr. Barth's paper presented before The American Society of Mechanical Engineers in January, 1909 (Transactions, Vol. 31) (*The Iron Age*, vol. 97, no. 9, p. 527, March 2, 1916, 7 pp., 3 figs.)

The Moment Diagram and Its Relation to the Reinforcement of a Concrete Beam, S. C. Hollister

Discussion of methods for solving some of the problems relative to the proper placing of the steel reinforcements in the body of the beam. In the article extensive analytical methods have been resorted to and a series of graphic construction introduced to determine the relative position of the component parts of the reinforcing materials. A method is set forth for placing the reinforcements for both bending and shearing resistance entirely from the moment diagram.

The author starts with the statement that the difference in moment between any two points along a beam is equal to the product of the average shear over the distance between the points, and that distance (this law is not strictly true for loads concentrated at points along a beam). From this the author derives first an expression of the average shear in terms of the changing moment along a portion s of the beam resisted by the stirrup, and then determines the moment increment from zero to a certain value M_s and finds that this moment increment represents the value of the adopted stirrup to resist the vertical component of diagonal tension over the portion s of the beam and that for any given stirrup of area a_s and of fibre stress f_s, the moment M_1 varies directly with jd, a value dependent upon the characteristics of the beam which gives the following equation:

$$M_1 = a_s f_s jd$$

From this he obtains the following equation:

For vertical stirrups $M_1 = 1.5\, a_s f_s jd$

For stirrups inclined at an angle θ to the horizontal:

$$M_1 = \frac{1.5\, a_s f_s jd}{\sin\theta}$$

For stirrups inclied at an angle of 45 deg. for the horizontal:

$$M_1 = 2.1\, a_s f_s jd$$

These equations express the final working value of the resistance offered by single stirrups in terms of an increment of moment. The author gives a graph of the different equations when $j = 7/8$, a very common value in rectangular beam design, with instructions how to use this chart. He then gives in detail the design of a T-beam in accordance with the above described method. He shows how to place the steel in the beam and indicates the application of the method with two arrangements of the steel, one in which the bent up rods are intended to carry a portion of the shear and the other in which the stirrups are designed to carry all the shear. (*The Wisconsin Engineer*, vol. 20, No. 5, p. 206, February 1916, 11 pp., 6 figs. *t.*)

Steam Engineering

Boiler and Steam Vessel Explosion in Switzerland, E. Höhn

Description of what was found in an investigation of an explosion of a vertical inclined tube boiler in Switzerland (the boiler was built by a concern in Hesse, Germany).

The boiler had a welded-in fire-box with three inclined tubes and was tested after construction (in 1898) at an hydraulic pressue of 11 atmospheres and later on in 1911 by an inspector of the Swiss Association of Steam Boiler Owners, at 9 atmospheres.

The inspection after explosion showed that the arched crown of the fire-box separated from the fire-tube along a welded seam and was pressed downwards as indicated in the drawing (Fig. 9) just as if it were an elastic membrane. After this the force of the steam naturally penetrated into the fire-box and violently threw the boiler off its foundations.

A close investigation of the broken seam showed that it was welded just along one edge, in fact, poorly welded—and iron filings could be broken off without much trouble. In addition to that the smoke-tube before being inserted into the hole in the fire-box which was apparently too big, was enlarged as shown in the figure, which likewise cannot be considered good practice. A further constructive defect was the curving of the fire-box crown while the bottom of the boiler was flat. Since the jacket and the fire-box did not expand equally when heated, the difference in length had to be equalized somewhere, and it is flat bodies having an elastic action which are best able to take up such an equalization. As soon, however, as a curved body is introduced the elasticity suffers.

It must not be forgotten in this connection that the stress of the spring action in the header is taken up by the smoke-tube and the seams between the latter and the bottom of the boiler. This stress increases with the rigidity of the bottom,

hence with its curvature. Corrugated smoke-tubes, while technically possible, are not usable even though they have a certain amount of elastic action.

The article describes also another case of explosion, this time of a container used under pressure with steam for industrial purposes. Of interest is the discussion of the etching test.

In the present case one of the seams was found to have broken at the flange and the author points out that such a wrong application of welding is found oftener than one would think. In this connection the author calls attention to the fact that with arched headers the maximum stress occurs at the flange as has been previously shown by the investigation of C. Bach.

As regards the comparative value of riveting and welding in boilers, the author repeats the following statement previously made in another of his publications: "A welded seam has always in it something hidden, beyond control. As a substitute for a riveted seam it is undesirable where the latter can be applied without difficulty. There are, however, cases where the welded seam may be or has to be applied for constructive purposes, with moderate stresses, or because of lack of space, etc." (*Explosion eines Dampfkessels und eines Dampfgefässes in der Schweiz, Betrachtungen über Schweissungen,* E. Höhn, *Zeits. des Bayerischen Revisions-Vereins,* vol. 19, no. 24, p. 195, December 31, 1915, 4 pp., 6 figs. *dp.*)

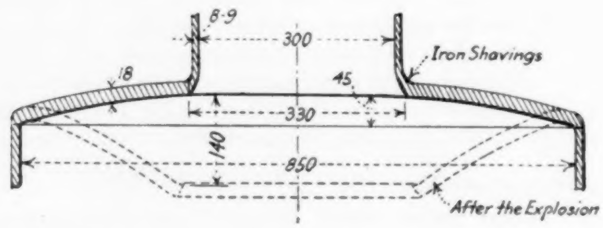


Fig. 9 Portion of the Boiler Affected by the Explosion

New Wisconsin Boiler Code

The Industrial Commission of Wisconsin has just issued the New Wisconsin Boiler Code to govern all steam boilers except those regularly inspected by the Federal government, steam fire engines, those used exclusively for agricultural purposes, all of less than 10 h.p. and those on which the pressure does not exceed 15 lb. The Code follows the requirements of the National Association of Stationary Engineers. (*The Iron Age,* vol. 97, no. 9, p. 560, March 2, 1916.)

Flow of Steam in Pipes, W. L. Durand

An article discussing methods of determining the sizes of steam pipes by the use of formulas and by a curve chart by which, if three of the four variables are known, the fourth can be found.

The writer proposes a formula in which the length of the pipe and friction loss are reduced to one variable "friction loss per unit of length" such as "per 100 ft." The formula is as follows:

$$W = 87.5\sqrt{\frac{p}{100}} \times \sqrt{D} \times \sqrt{\frac{d^5}{1+\frac{3.6}{d}}}$$

where W = weight of steam flowing in pounds per minute, p = drop in pressure pounds per square inch, D = density, pounds per cubic foot, d = internal diameter of pipe.

In addition to this formula the author gives a chart for quickly determining the fourth variable in this formula if three of them are known. (*Power,* vol. 43, no. 10, p. 324, March 7, 1916, 2 pp., 1 fig. *p.*)

Peat Burning Furnace for Locomotives

There have been references in American papers several times in the past year to the Porat system of peat burning in locomotives. In the present article is described from a German patent (No. 287837) the construction of this furnace which has been already extensively experimented with on the Swedish railways. The essential element of this system is a connection between the fuel supply and the valve gear of the locomotive which serves to regulate the draft by the blast pipe and an auxiliary blower. This connection is arranged in such a manner that fuel can be supplied only at a certain normal strength of blast. In the illustrations, Fig. 10A gives a vertical cross-section of a locomotive fire-box with the new arrangement and Fig. B a similar cross section through the fuel hopper, while Fig. C gives two views of the adjusting gear.

The fuel is led from the funnel shaped container *a* on the tender to the fire-box *d* through the pipe *c*. The fire-box is closed in front by door *e* in a passage for the air of combustion, in which passage there is built a regulating valve *l*. On the fire-box is also installed a separate chamber *n* for solid fuel fed with air through passage *o*. Liquid or gaseous fuel can be admitted through pipe *p*. A slight fire is maintained in the chamber *n* which furnishes sufficient heat to ignite the peat powder when the supply of fuel has been renewed after an interruption of the supply.

The fuel pipe *c* opening into the cap *e* has its free end bent upwards and ends in a funnel *f*, opening under the container *a*. Air can enter into pipe *c* through the opening *g* in the rear of the funnel. The container *a* is provided with a bend and a valve to regulate the fuel supply. The arrangement is such for example that the steam cylinder receiving steam from the boiler has its valve gear regulated by the throttle lever *t* located on the locomotive or by the valve of the auxiliary blower.

The slide valve *h* is located in front of the discharge opening of the container *a* and is connected with the rod h^1 of a piston h^2 moving in a cylinder. This latter receives its steam also from the boiler and has a valve gear regulated in a similar manner. The piston h^2 is forced into the closing position of the valve *h* by means of a spring. The nuts h^3 on the piston rod h^1 are used to adjust the sliding valve *h* in proper position with respect to piston h^2 so as to vary the dimensions of the fuel discharge opening. The regulating shaft *q* which opens and closes the steam valve leading to the working cylinders of the locomotive is provided with a handle *t* located above the fire door. The article describes in detail the connection with the auxiliary blower. (*Zeits. für Dampfkessel und Maschinenbetrieb,* vol. 39, no. 3, p. 19, January 21, 1916, serial article, not finished.)

Varia

Proposed Standard Numerals for the Scales of Measuring Instruments, A. P. Trotter

Discussion of the outward appearance of numerals for the scales of measuring instruments. The paper is published at the suggestion of the Meter Panel of the Engineering Standards Committee on Electrical Accessories (Great Britain).

The paper compares three sets of numerals proposed as

standards. The principal characteristics of the numerals proposed by the author are as follows: There should be no serifs; the figures should be of block character, that is, there should be no marked difference in the thickness of the line in any part of the figure; with a height of 10 units, the width ought not to be less than 7 units, as otherwise legibility begins to suffer, while a greater width is a waste of space; the thickness of the line should not be less than one-twentieth of the height of the figure, that is, half a unit, nor greater than 1½ units.

As regards individual figures, the 0 should be an ellipse with the height 10 units. In 1, if any serif is used, it should be a very small one to avoid confusion with 7. In 2, the width is 7 units and the upper part of the figure should be half an ellipse. For the sake of legibility, a curve at the lower part of the breast is much better than a straight line making an acute angle with the bottom bar. In designing the figure 3, care must be taken to avoid confusion with 5, as well as with 8. For this reason the author recommends the flat topped 3. To emphasize the difference from 5 the upper part should be set back a little to the right. The 4 is with the stem united to the sloping line, with the line one unit thick; the lower side of the bar should be 3 units from the base line and the bar should overhang to the right 2 units which gives a slope of three in two for the slanting line.

In 5 the line joining the bar with the lower part is not quite vertical but has a slope of one-half unit in five; more would tend to confusion with the 3. The lower part of the 5 should consist of about three-quarters of a circle of outside diaemter of 7 units. The top bar may be 5.5 units long. In drawing the 6, care should be taken to provent confusion with 8 and with zero. The author proposes that the lower part should be an ellipse, width 7, height 6, and the upper part an arc of 7 units radius struck from the end of the major axis of the ellipse. The 9 is simply the 6 reversed. The top bar of 7 should be 7 units wide and the down stroke should have a slight curvature, say 30 units radius. The 8 consists of two slightly unequal parts with the major axis of 6 for the upper part, and a minor axis 5 units, while for the lower part the minor axis is 6, making the middle of the common line 5.5 units above the base. (*The Journal of the Institution of Electrical Engineers*, vol. 54, no. 255, p. 273, February 1, 1916, 2 pp., 5 figs. *g.*)

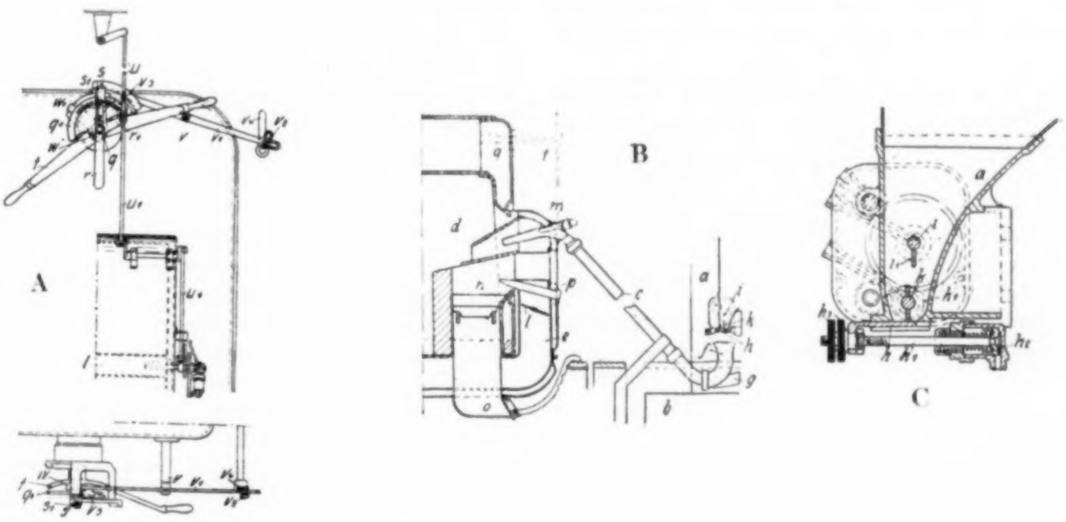


FIG. 10 PEAT BURNING ARRANGEMENT FOR LOCOMOTIVES

THE SMALL OSCILLATIONS OF A KITE, Professor G. H. Bryan

The mathematical investigation of the small oscillations of a kite.

The main difficulty which distinguishes the problem of the kite from that of the aeroplane is connected with the action of the kite string, and as it is uncertain how far it would be worth while to give a general solution of the problem, the paper is limited to the consideration of the small oscillations of the kite about its position of equilibrium. In this case, the expressions for the linear and angular accelerations for fixed and moxing axes become the same, while the conditions introduced by the forked string may be satisfied by treating the point of attachment as being different for the longitudinal and lateral oscillations.

In this paper, equations are formulated for the general case in which the string is of finite length and extensible, and particular modifications occur when the string is inextensible and when it is practically infinite in length. Neither the weight or inertia of the string, nor wind resistance on the string are taken into consideration.

Among other things, it is of interest that the author uses the method of cross multiplication in writing down some of the expressions, because, as he states, he finds it of very great use in writing down the equations of motion of a rigid body or the six components of a system of forces; it is well that anyone who is obliged to make use of these formulae should know of this simple method of writing them down.

The paper covers the general equations of small oscillations with the center of mass as the origin, and the changes of constants due to displacement of the vectors representing the components of tension, gravity, and wind velocity with the rotation of the axes.

The problem of lateral oscillations is considered for the cases of an infinitely long string of a plane kite without keels or auxiliary surfaces offering no tangential resistance, and for the case when the point of attachment is fixed. The longitudinal oscillations are considered for the case where the string is of finite length and extensible; finite but inextensible; infinitely long and inextensible; very extensible, and finally when the point of attachment is fixed. (*The Aeronautical Journal*, vol. 19, no. 76, p. 114, October-December 1915, 8 pp., 1 fig. *tm.*)

Turbo-blowers and Compressors, H. L. Guy and P. L. Jones

General discussion of the theory and to a certain extent practice of turbo-blowers and compressors from a paper read before the South Wales Institute of Engineers.

The paper discusses the advantages of the rotary type of machinery of this kind as compared with the reciprocating type and then passes on to the theory of design and operation of turbo-blowers. It takes up general formulæ, the question of the surging point, the effect of the use of blades of various shapes and presents some formulæ on design. It discusses also in considerable detail the question of governing. A similar discussion is given in connection with turbo-blowers.

The subject of commercial testing of blowers is discussed in detail, the formula and calculation being given in the article. An appendix describes a convenient and accurate method of measuring large air quantities. (*Engineering*, vol. 101, no. 2615, p. 143, February 11, 1916, 6 pp., 20 figs. *dt.*)

Two-stage Air Refrigerating Plant for Dry Blast

Discussion of various methods of desiccation of air for blast furnaces, in particular those based on air cooling and depositing of the moisture in the form of a condensate or frost.

The first step in the way of an improvement on the original Gayley process was the application of two-stage refrigeration. Since the air has to be cooled from perhaps 80 deg. fahr. down to about 16 deg. fahr., it is clear that if the whole of the cooling be carried out at one constant back pressure on the refrigerating plant, there will be a great waste both of refrigerating capacity and power, for that back pressure would have to be such as to produce an evaporating temperature for the ammonia within the refrigerating system low enough to cool the air to its lowest limit of 16 deg. fahr.

When the two stages of the cooling are kept separate, a different back pressure can be used for each and this means a considerable economy since at higher back pressures both the density and the latent heat of ammonia are increased; that is the useful refrigerating effect per stroke of the compressor piston is greater. The effect is also produced per ton of refrigeration so that the net result is a smaller plant for the same duty operating at less expense. From data taken from a plant erected for the Steel Company of Canada at Hamilton, Ont., it was found that in the first stage the temperature is so high as to preclude the formation of frost, and only second stage cooling pipes require thawing off.

In the two-stage system adopted by Messrs. Haslam, of Derby, water instead of brine is used for the first stage cooling. They use an interesting type of cooler consisting of a series of direct expansion cooling pipes in conjunction with batteries of galvanized corrugated steel plate over which the water or brine trickles. All the frost that would otherwise be formed in the second stage is carried away in the brine and the latter can be brought up to strength as required by evaporation or addition of fresh calcium chloride.

Of a still more recent design is the dry blast plant of L. Sterne & Co., Ltd. using the so-called Heenan cooler (for a complete description of this cooler see *Engineering*, Sept. 4, 1914, page 313). The principal parts of this cooler are a casing, a drum which revolves slowly within the casing, and a fan. The lower part of the casing is formed into a trough which is filled at one end with water and at the other with brine, both cooled by the refrigerating plant. The air in its course through the cooler meets the water first and after that the brine and is progressively cooled by these two agents to its final temperature of 25 deg. or below. Shell coolers are used for refrigerating the water and the brine, and the ammonia suctions from the two coolers are taken to different compressors at different pressures, so realizing the benefits of two-stage compression.

An important feature in the action of the cooler is that the cooling liquids are picked up in thin films and not by drops or globules as in the cases where the liquids trickle downwards over the cooling surfaces. Hence there is no danger of moisture being entrained by the air and carried over to the tuyeres. A chart given in the article shows that while the air before cooling has a humidity varying from 3.5 to 11.6 gr. per cu. ft., it leaves the apparatus with a fairly constant humidity, averaging about 0.75 gr. (*Engineering*, vol. 101, no. 2615, p. 125, February 1916, article not finished. *d.*)

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L'Etat actuel de l'Aérodynamique, L. Marchis. L'Aérophile, vol. 24, no. 1-2, Jan. 1-15, 1916, 4 pp.

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